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# Walkable City and Military Enclaves: Analysis and Decision-Making Approach to Support the Proximity Connection in Urban Regeneration

**Ginevra Balletto [1,*], Mara Ladu [1], Alessandra Milesi [1], Federico Camerin [2] and Giuseppe Borruso [3]**

[1] Department of Civil and Environmental Engineering and Architecture, University of Cagliari, Via Marengo 2, 09123 Cagliari, Italy; maraladu@hotmail.it (M.L.); alessandra.milesi@gmail.com (A.M.)
[2] Department of Architecture and Arts, Università Iuav di Venezia, Santa Croce 131, 30135 Venice, Italy; fcamerin@iuav.it
[3] Department of Economics, Business, Mathematics and Statistics "Bruno de Finetti", University of Trieste, Via A. Valerio 4/1, 34127 Trieste, Italy; giuseppe.borruso@deams.units.it
* Correspondence: balletto@unica.it

**Abstract:** Accessibility and urban walkability are the cornerstones of urban policies for the contemporary city, which needs to be oriented towards sustainable development principles and models. Such aims are included in the objectives of the 2030 Agenda, as well as in the ambitious objectives of the 'European Green Deal'. These concepts are closely linked to the paradigm of a sustainable city—livable, healthy and inclusive—based on a system of high-quality public spaces and on a network of services and infrastructures, both tangible and intangible, capable of strengthening and building new social, economic and environmental relationships. It is necessary to recognize potential opportunities for connection and permeability in consolidated urban environments. These are very often fragmented and are characterized by enclaves of very different kinds. Ghettoes and gated communities, old industrial plants and military installations and facilities, to cite a few, represent examples of cases where closures on urban fabrics are realized, impeding full walkability and accessibility. Within such a framework, the present research is aimed at focusing on a particular set of enclaves, such as those represented by the military sites being reconfigured to civilian use, a phenomenon that characterizes many urban areas in the world; in Europe; and in Italy, in particular, given the recent history and the Cold War infrastructure heritage. In such a sense, the city of Cagliari (Sardinia Island, Italy) represents an interesting case study as it is characterized by the presence of a series of military complexes; real 'enclaves' influencing the proximity connections; and, more generally, walkability. 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 paper proposes and applies a methodology to evaluate the effects of urban regeneration on walkability in a flexible network logic, oriented to the '15 min city' model or, more generally, to the renewed, inclusive, safe "city of proximity", resilient and sustainable.

**Keywords:** city of proximity; walkability; 15 min city; urban regeneration; urban enclaves; green military barracks

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## 1. Introduction

The process of economic transition from the old to the new economy affects cities and territories. The modification of the production structure has, in fact, led to a substantial urban change with several phenomena of decommissioning of buildings and latent abandonment. 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, boosted the conversion phase, with public administrations and investors developing proposals for urban regeneration [1–4].

Furthermore, the need to adopt sustainable urban development models [5–7] to favor the ecological transition based on environmental protection [8,9], from the reduction of land consumption to the circular economy [10,11], validates the relevance of the theme of disused buildings [12,13] that, in fact, play a central role in the scientific debate on urban governance [14].

The divestment of the buildings mainly affects the historic city, highlighting the progressive need for urban regeneration [15] with the aim of offering new spaces that can also be used to respond to the new health and wellness needs deriving from the pandemic [16,17]. The COVID-19 epidemic highlighted, in fact, important critical issues in both inner houses and urban spaces, which can be overcome partly through the urban regeneration of disused buildings. In this sense, a process of urban regeneration aimed at the transformation of such spaces contributes to changing the condition of buildings disused from anti-commons to semi-commons [3,18] and can help promote the city of proximity [19–25]. As a matter of fact, military enclaves have characteristics typical of the so-called 'anti-commons', a concept introduced in the 1980s to explain the under-use of a resource caused by the right of ownership, in contrast to the well-known concept 'common'. The concept of semi-common is well suited for a new interpretation of those areas that present a mixture of civil and military uses in time and space. This concept, in fact, interposed between that of commons and anti-commons, establishes an interaction between public and private property and 'allows the right holders to benefit from the joint use of the resource'. The semi-commons, in fact, incorporates all private collective rights but at the same time attributes a series of public rights to other subjects, such as those arising from military use [23–25].

Furthermore, the city of 15 min or the city of proximity [20–22] appears as a derivation from the concept of "neighborhood unit" (1923) and aims to ensure sustainable walkability 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 min, however, also clashes with the consolidated urban layout of the cities, including the enclave effect caused by disused buildings. Based on this assumption, in 2019 the Italian Army presented the "Large Infrastructures—Green Barracks Project (GBP)" (Ministry of Defense (2019)) to improve the environmental and architectural quality within broader urban regeneration processes. In particular, the urban regeneration policies focused on environmental, economic and social sustainability, combined with the Walkable City approach—from the mix of land use to tactical urban planning [26–30], facilitating the overcoming of the enclave condition of military sites. Furthermore, although urban walkability is central to the urban policies of the contemporary city increasingly oriented towards sustainable development models—Agenda 2030 and the European Green Deal—its implementation suffers from fragmentation caused by disused buildings, both military and civil.

In this synthetic framework, from the observation and analysis of such a technical document, the main purpose of this work is to analyze and quantify the effects of the urban regeneration of an urban military site on the walkability of proximity. Such a case study, more generally, can be referred as typical and representative of urban examples of gated urban areas gated or those closed to the public.

For this evaluation, a composite index, named Walkability in Big Buildings Index (WBBI), was implemented and used to compare the state of the art before and after urban regeneration—ante and post operam. 'Ante operam' refers to the current situation with the presence of urban enclaves characterized also by military infrastructures and facilities. 'Post operam' refers to the situation after the realization of urban regeneration (GBP), with the partial opening of the area to civil use.

The contribution's importance is twofold. On the one hand, the focus is on the important issue of dismissed/downsized military areas and their potential re-use for urban functions and services. On the other hand, and more generally, the contribution is a reflection of the potential of urban pedestrian accessibility and walkability by opening

urban enclaves, phenomena that have become more and more widespread in many urban environments around the world.

The rest of paper is organized as follows:

- Section 2 is a literature review that focuses on walkability and accessibility; the post-COVID-19 city; and the regeneration of the urban military sites.
- Section 3 describes a case study of military sites in the city of Cagliari, Sardinia, Italy.
- Section 4 describes the proposed methodology and the application to the case study.
- Section 5 contains the discussion.
- Section 6 contains the conclusions and development plans.

## 2. Literature Review

This section reports the literature review on the three main themes dealt with by this paper, i.e., walkability and accessibility; the post-COVID-19 city; and the redevelopment of a specific set of public-owned assets, i.e., former military sites, in Italy. The common thread of these themes is the fact that they may boost specific urban regeneration projects, and the study case is about putting them together to propose innovative ways of regenerating urban environments.

### *2.1. Walkability and Accessibility*

The application of walkability principles for a more human-centered urban accessibility is at the core of current urban regeneration principles, such as health, livability and sustainability, even though neither practitioners nor scholars agree on a universal definition [31]. The quality of walkability is defined by how well the built environment enables slow mobility [32]; however, as recently stated by Baobeid, Koç and Al-Ghamdi [33], no universal standardized walkability theory has been released for policy makers and developers. Therefore, there is an increasing need to combine the land-use planning and transport across Europe due to the spreading environmental issues caused by vehicular traffic in the form of gas emission, noise, land pollution and water [34]. Walkability as a solution for polluted urban environments has been highly encouraged by the fact that the most crucial feature of severe COVID-19 is its transmission via droplets and aerosols [35]. The change of human mobility patterns towards slow mobility was consequently prompted to lower the COVID-19 contagious rate worldwide [36,37].

Despite the growing attempts to provide feasible guidelines towards a carbon-neutral mobility in the long-term [38], the tactical measures on mobility have often been temporary or not integrated into longer-term planning scenarios for developing mobility transition pathways [39,40]. The exploration of cities' attempts in the post-COVID-19 period is fundamental to understand the way walkability and accessibility are addressed today, being supported by numerous international networks of cities such as the C40 Cities [41], and the success or failure of these measures.

### *2.2. The Post-COVID-19 City*

Throughout history, epidemic diseases shaped cities in terms of physical layout, management and urban lifestyle. Urban planning as a discipline was born to deal with contaminated and infectious urban environments. As in the past, urban planning today is dealing with the 2020 pandemic outbreak to shape resilient and sustainable cities, in contrast to the side effects of the city-making process under neoliberal urbanism dynamics [42]. COVID-19 has apparently accelerated innovative measures aimed to redevelop the existing urban environment [43]. Despite being introduced in the pre-pandemic period, solutions such as the 15-min city [44], Superblocks [45,46] and Tactical urbanism [47] are being increasingly applied across the world [48]. It is claimed that they provide the 'Right to the City' [49], to deal with environmental issues and to address the impacts of climate change by providing a healthier and human-centered environment. Their increasing application since 2020 [50] seemingly relies on the findings of epidemiologists regarding the causes of COVID-19-related rate of infections. People living in areas with high air pollution index

and extreme meteorological conditions have higher risk of mortality [51–53] and COVID-19 in particular hits deprived neighborhoods [54,55] and exacerbates urban issues such as socio-spatial segregation [56].

Solutions for improving walkability and local accessibility may deal with these issues [57], thus matching the European-fostered program "European Green Deal" [58] launched in December 2019 [59], whose implementation is being delivered by the so-called New European Bauhaus [60]. This solution aims to carry out cities' urban regeneration on a temporal basis according to which workplace, essential services for urban life and amenities—such as green spaces for sport and leisure—can be reached by slow mobility within 15 min by residents. Large cities such as Paris and Milan are trying to apply this vision to their urban environment [61], and Barcelona [62], Berlin [63] and Vienna [64] are experimenting with the implementation of the Superblocks' principles. The 15-min city and the Superblocks aim at a more human-centered mobility that will help cities to recover from the pandemic while reducing dangerous pollution. Other authors focused on different ways of measuring walkability, both considering urban centers and peripheries, as well as including the citizens' participation in the planning process [19,65,66].

### 2.3. The Regeneration of Urban Military Sites

A relevant aspect of the application of the 15-min city can be the development of local and regional scales of urban planning strategy that may give new life to the vast amount of urban voids located within cities [67], even though the analysis of this aspect is still at its beginning in the current literature [68]. If we take into consideration the case of Italy and specifically a branch of the unused public-owned assets [69,70], 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 healthier and safer urban life for citizenship [71]. After more than 30 years of failing public policies to reuse these assets [72] and increasing research at international and national levels [73–76], the recovery of former military sites may take advantage of new approaches in line with the post-COVID-19 city needs.

The redevelopment of Italian military assets and, in particular, the recovery of the unused barracks complexes is in line with the twofold objective: improve the architectural quality of the existing building stock and encourage urban regeneration processes of wider contexts, 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 Project (GBP)" (Ministry of Defense (2019)) [77,78].

The GBP, dedicated to the study and the future construction of a new generation of military infrastructures, foresees a total investment of 1.5 billion over 20 years (Figure 1). Inspired by innovative construction criteria, it is primarily geared toward modernization and renewal of military assets, with the intention of achieving high-quality standards for working environments and, at the same time, activating and strengthening the interaction between the barracks and the local context. The new military bases have a functional organization aimed at promoting the 'dual use' approach to structures and greater social inclusion: sports/recreational functional areas represent elements of union between the army and the local community [79,80]. For this reason, the GBP, if properly channeled and inserted into urban planning analysis and policies, can allow for the transition of military enclaves from anti-commons to semi-commons-commons [6,25].

However, in this study we argue that the performance of the GBP will also depend on a broader sustainable urban mobility planning framework, in favor of the Walkable City paradigm [81–83].

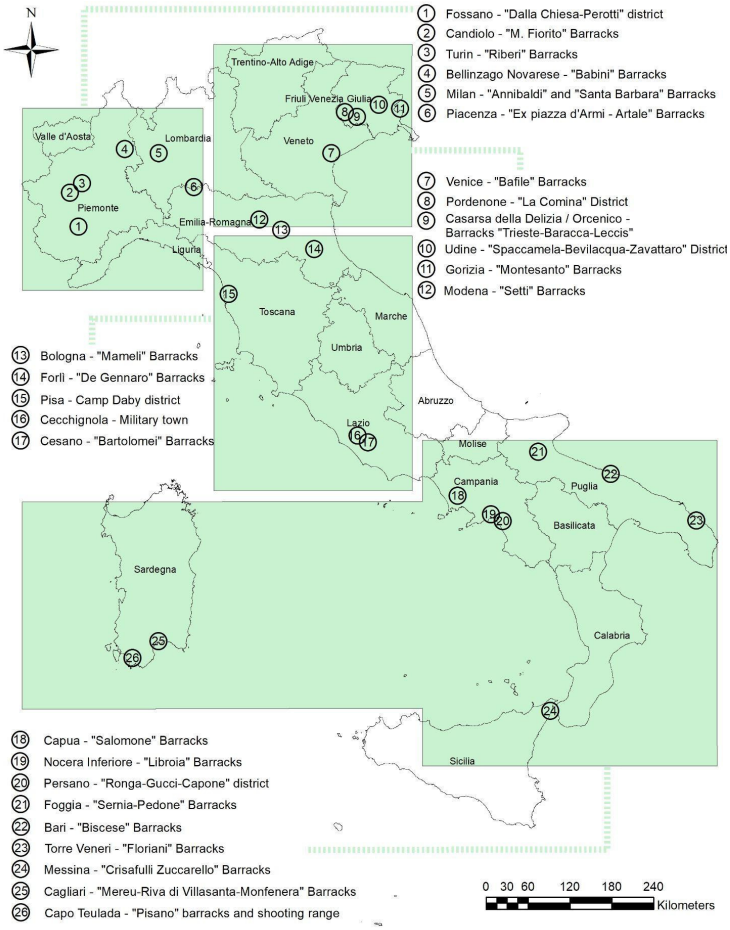



**Figure 1.** Location of the 26 military sites included in the Green Barracks Project—GBP. Source: Ministry of Defense (2019). Authors: Milesi A. and Ladu M. (2021).

## 3. The Case Study of the Military Sites in the City of Cagliari (Sardinia, Italy)

The issue of the presence of military sites in urban areas or in close proximity to them is particularly relevant in formerly militarized areas such as Southern Italy, in terms of its role during the Cold War in the Mediterranean area. Sardinia represents a particularly noticeable case, as its geographical location and extremely low population density make it a strategic region in the NATO (North Atlantic Treaty Organization) defense system, other than being, as it still is today, an important training area. Such a heritage of military installations of reduced use represents here, in other parts of Italy, and in rest of Europe, a challenge for their conversion to different uses, particularly in urban areas.

In this framework, the city of Cagliari is the capital of Sardinia Region and since 2016 it has been a Metropolitan City, a new administrative structure of 17 municipalities. The Municipality of Cagliari hosts over 150,000 inhabitants, while the Metropolitan City spans over 400,000 inhabitants. Cagliari is the most important cultural, economic, political and administrative center of Sardinia. It plays a role as the major urban area in the Island, as well as a military headquarter for the simultaneous presence of important installations and bases of the different forces, namely Italian Army, Navy and Air Force. As a result, we can register important figures (58 units) of military buildings and barracks, offices, and residences, in terms of their extension, at about 2 million sqm, and their urban location [63]. Furthermore, The City of Cagliari is affected, like many other Italian cities, by phenomena of decommissioning and potential abandonment of public and private buildings, as a consequence of the changing role played by cities in terms of different economic activities. Many of these buildings and areas are very often characterized by historical–architectural values that require urban regeneration [82]. The Strategic Plan of the Metropolitan City of

Cagliari is based on these assumptions (2021) [9,84]. Some military buildings have already been transferred from the Military Property to the Autonomous Region of Sardinia [85], becoming usable for the community [86]. This is a process started in the early 2000s for the redevelopment of the barracks to meet the needs of the community within the broader framework of the objectives: these include the 2030 agenda and climate neutrality [87], through the models of the Walkable City, the 15-min City, the Safe and Healthy City and the Sport City.

The military barracks occupy large areas with respect to the surrounding urban fabric, exceeding 10,000 square meters. The crossing inhibition therefore determines a circumnavigation of the entire compounds. This can be also observed by means of the analysis of the 'smart' tracks' density, available through the Strava digital platform (Figure 2), where walkers, runners, cyclists, etc. record their training performances. Such a platform can be used to highlight the geo-referenced digital traces of slow mobility—walking, running and cycling—overlaying them with the urban fabric and therefore observing the relationship between physical and urban constraints and mobility.

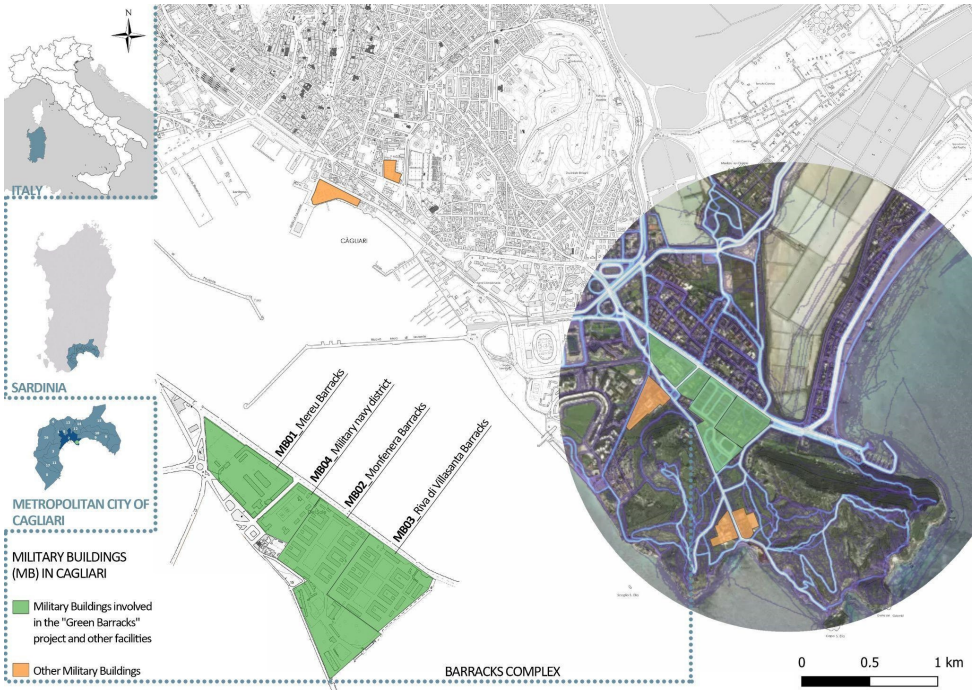



**Figure 2.** Geospatial location of the military barracks in the city of Cagliari. Below, detection of the tracks recorded by the smart community through the Strava digital platform (30 September 2021). Authors: Milesi A. and Ladu M. (2021).

The heat map portion in Figure 2, on the right, taken from Strava digital platform, highlights the separation effect on the road network from the big enclaves. We developed a research methodology to study the separation effect and, more generally, the enclave phenomenon from the observation of phenomena such as those presented so far, combining direct field observations and indirect ones on the digital traces from sport and leisure activities.

The aim was to define an index of representativeness regarding how the urban walkability would change in cases in which big buildings and enclaves would be opened to pedestrian crossing.

The proposal is that of a Walkability in Big Buildings Index (WBBI), which is, in turn, a function of three main factors related to walkability and services supply: porosity (PI), crossing (CI) and attractiveness (AI).

## 4. Methodology, Data and Results

### *4.1. Methodology: Porosity (PI), Crossing (CI) and Attractiveness (AI) Indices and Composite Index—Walkability in Big Buildings Index (WBBI)*

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 also the significant expression of mobility in the urban environment with multiple benefits—related to environment, health and well-being, both individual and collective [88,89]. The method was implemented to evaluate the possible changes in the urban connections by means of opening new possible passages and routes inside enclaves or huge buildings. In doing so, a change in the walkability perception by pedestrians would result in different ways of connecting different parts of the city, de facto creating a modified network of walkable connections. Such set of urban walkable connections is alternative to the traditional one, that is, it is based on sidewalks and squares, that present themselves as expressions of the road network and therefore driven by an automobile-oriented set of planning policies.

In particular, the method is based on the combination of the following factors, related to different characters of the facilities: building area; number of crossings; and number and variety of the main urban proximity functions, 15 min ante and post operam of actions proposed in the Strategic Plan of the Metropolitan City of Cagliari (2021).

This method, already developed and applied in the main public enclaves of the historic center of Cagliari, consists of the definition of the Walkability in 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 the reduction of the enclave effect [68]:

(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 following formula: [89].

$$PI = Rc \times p_p$$

where $R_c$ = the ratio, in percentage, between covered area referred to as 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 that closely related to the conditions of the reference context, but if $R_c = 0$ then $PI = 1$.

In other words, as $R_c$ decreases, the weight pp increases in order to appreciate the empty area included in the building areas functional for walkability (see case study, Paragraph 5).

(2) Crossing index (CI): The crossing index specifies the level of crossability that characterizes each barrack 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 in the following formula:

$$CI = Nc \times p_c$$

where $N_c$ = number of crossings that unfold between two accesses and that allow us to relate more urban portions and $p_c$ 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).

(3) Attractiveness index (AI) refers to both the number and the variety of central places found within a 15-min 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, is represented as follows:

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

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

$$N = \sum_j Nj$$

where $\lambda$ 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 [90–92], 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) Walkability in Big Buildings Index (WBBI). The indexes PI, CI and AI were integrated by the authors into a composite index, the Walkability in Big Buildings Index (WBBI), in which is applicable to the historic center of the city of Cagliari. In particular, the WBBI is the sum of the weighted (pk) indexes (PI, CI and AI), where the sum of weights equals 1. To distinguish this index from the others, a 100 basis was used. The WBBI was calculated in the following formula:

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

where $p_k$ represents the weight attributed to each index in relation to the urban form of the military enclave and its proximity contexts, extrapolated empirical evaluation of the Municipal Urban Plan [93] and the Strategic Plan of the Cagliari city [94].

### 4.2. Study Area and Data

The peculiarity of the Cagliari case study lies in the location of the military areas to be redeveloped and concentrated between the district of San Bartolomeo and the promontory of Sant'Elia, in a landscape context characterized by significant environmental components and geographic endowments [9], mixed with historical military settlement processes [95,96].

In particular, the case study consists of a barracks complex with a total area equal to 279981.325 sqm (MB = military building; MB01 = 36764.967 sqm; MB02 = 129806.581 sqm; MB03 = 84081.493 sqm; and MB04 = 29328.315 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 mixed civil–military use of some portions, we propose the addition of a new set of segments, implementing de facto a new network to cross the complex, indicated with a red line (post operam) (Figure 3).

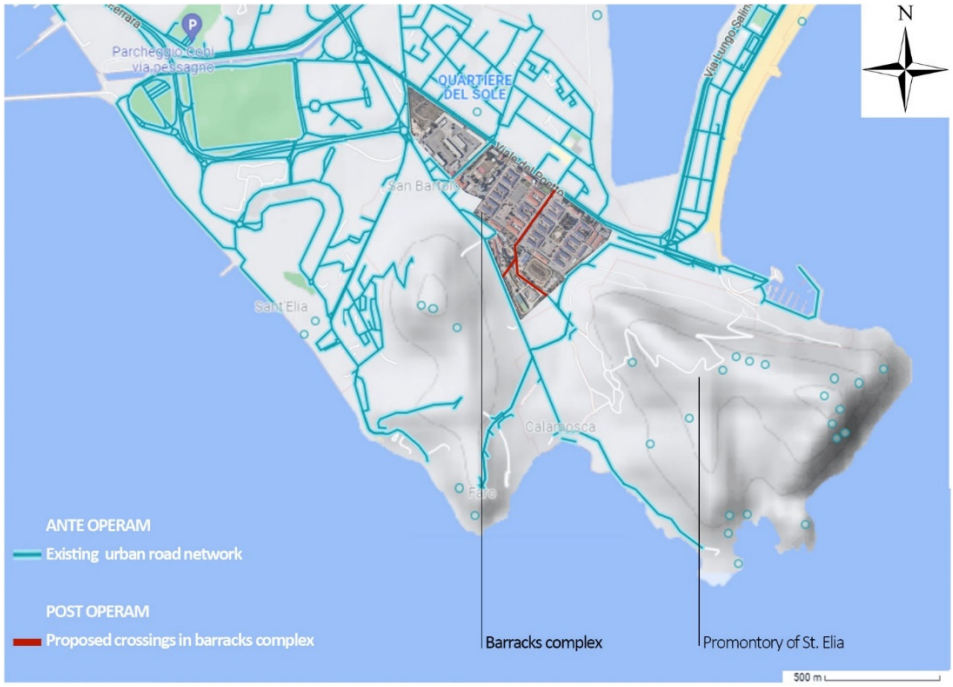



**Figure 3.** Representation of the barracks complex ante (light blue line) and post operam (red line). Base map from Google Maps. Authors: Milesi A. and Ladu M. (2021).

We then proceeded to evaluate the indices (PI, CI, AI and composite index WBBI), applied on two different scenarios, as the "ante operam" and "post operam" ones, as foreseen from the aforementioned 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 it derives from the relationship of urban saturation and from the transport infrastructures and allows for the representation of the urban contextualization [97] (Figure 4).

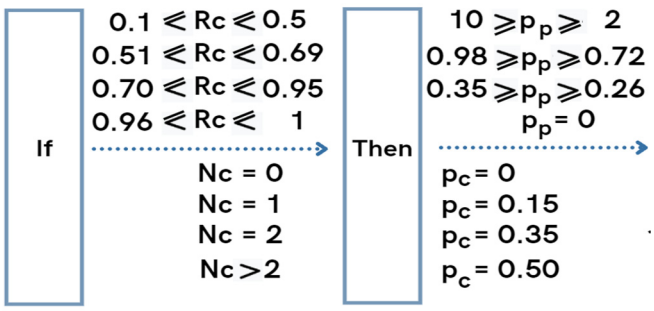
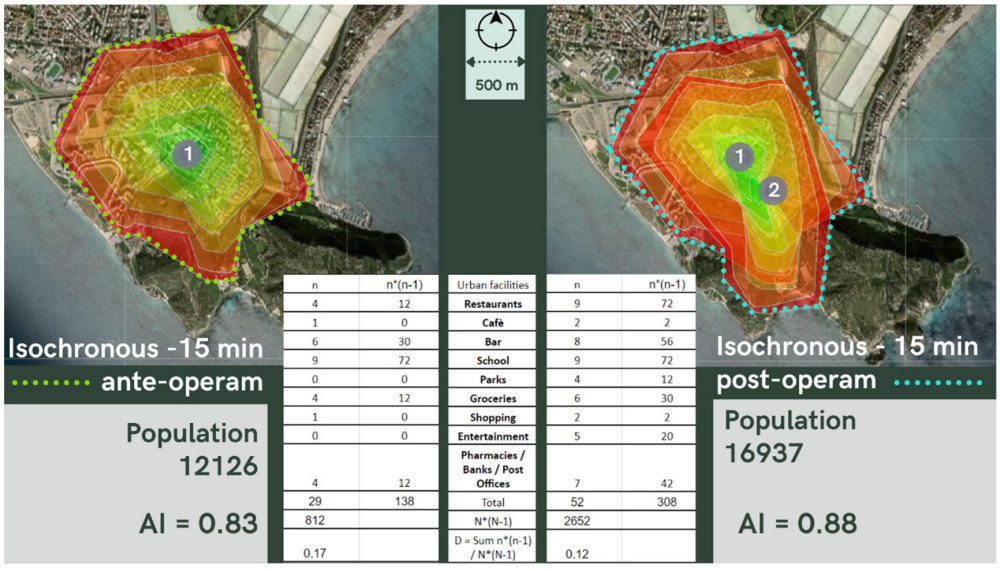



**Figure 4.** PI and CI of the barracks complex (MB01, MB02, MB03 and MB04).

### *4.3. Results*

The assessment of the attractiveness index (AI) to the case study was developed through the geospatial localization of urban proximity services. This was possible by means of the walk score application [98], which allows, in each area, one to search for the number of services and economic activities from any point in space. In the present case, this was done by running the algorithm through the platform, starting from the center of the barracks' area, using a range, drawn from a network, of about 1200 m, or an urban space of about 15-min walking distance. The algorithm was performed considering the situation of both ante and post operam (Figure 5).




| 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 (intervals 2 min) 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, last accessed 1 October 2021.

By the observation of Figure 5 with the two simulations—ante and post operam, respectively, on the left and right sides of the image—it is possible to highlight how in the post operam case, there is an important increase in urban facilities and relative potential increase of the beneficiary population. The ante operam scenario is in fact showing an AI of 0.83, which increases to a value of 0.88 in the post operam. The picture portrays the overlapping of the ante operam catchment area—centered on point 1, from which 10 sochrones 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 the end, for the evaluation of the WBBI, we considered $p_k = 0.33$ for PI, $p_k = 0.33$ for CI and $p_k = 0.33$ for AI, because no particular urban context conditions were found that would justify the differentiation of weights.

| | | Ante-operam | Post-operam | |
|---|---|---|---|---|
| | Porosity Index (PI) | | | |
| INPUT DATA | $R_c$ | 0.23 | 0.23 | |
| | PI | 1 | 1 | OUTPUT DATA |
| | Crossing Index (CI) | | | |
| INPUT DATA | N. of crossing | 1 | >2 | |
| INPUT DATA | $P_c$ | 0.15 | 0.5 | |
| | CI | 0.15 | 1 | OUTPUT DATA |
| | Attractiveness Index (AI) | | | |
| INPUT DATA | Urban facilities | 29 | 52 | |
| | AI | 0.83 | 0.88 | OUTPUT DATA |
| | Walkability Big Builiding (WBBI) | | | |
| | WBBI | 60 | 85 | OUTPUT DATA |

**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 5.

## 5. Discussion

In this work, we proposed and applied a methodological approach, already applied in other research works, to evaluate indices for the analysis and decision support in the context of 15-min city. Through PI (porosity index), CI (crossing index) and AI (attractiveness index), a combined WBBI index (Walkability in Big Buildings 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 derived from the urban regeneration project of the green barracks project (GBP).

This research work using the diversity index (Simpson) has also made it possible to experiment with the role of diversity of urban services for pedestrian attractiveness. 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 was possible to relate intrinsic elements (PI and CI) with extrinsic elements (AI) of a certain large building that constitutes an urban enclave (as military barracks) to evaluate current and future pedestrians, 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) to 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 diversified relative attractiveness. The evaluation of the ante operam indices (PI = 1; CI = 0.15; AI = 0.83; WBBI = 60) and post operam indices (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.

The extent of such research work can be considered within a wider framework of urban issues and proposals for improving the livability at urban level. The research hereby carried on and presented, in fact, is part of wider considerations to 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 such as hospitals, exhibition areas and 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 defense. The changes in military operations and uses as well as, and particularly those at geopolitical levels, left on the ground an important and massive number of buildings and complexes, often in close proximity to urban areas, now partly used for military purposes and, in many cases, needing important maintenance, although this is not always possible. Few studies, however, have been realized so far that have included military areas within 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. Accordingly, the paper hereby presented was aimed at providing some suggestions on research directions in terms of walkability, and a different perception of urban spaces.

## 6. Conclusions and Future Development

The present study constitutes an application of a methodology developed in the context of broader research activity on the challenges of urban governance at promoting the redevelopment of military real estate from 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, including 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 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, must not be limited to considering such single cases but to 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 both spontaneous and induced formations of enclaves, as gated communities or ghettoes, following a trend toward self-isolation of social and economic groups, or as a form of defense, and an identity system. This is very much leading cities to develop isolating parcels of land that become more and more separated by other neighboring contexts, making them individual 'cells' in an urban body, hardly 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 more efficient and sustainable urban planning.

The future prospects of this research are to extend to the main Italian cases of barracks in metropolitan cities (Figure 1), to support the decision-making processes derived from the green barracks project (GBP). Other Italian (and European cities) are characterized by a similar presence of military installations, as well as non-strictly urban environments, as border regions. These latter cases will be the focus of future research, where the above-mentioned methodology will be applied. The international level will be also considered, in particular, adapting the above-mentioned methodology to the other urban situations in which enclaves and gated areas will be highlighted.

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