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SANTA BARBARA 4.0

Smart Military District: Urban Rethinking, Energy Efficiency and Smart Things

Executive summary

In Italy, most of the military infrastructures are inadequate in terms of liveability, energy efficiency and structural characteristics. This issue generates inefficiency and wastes of valuable resources. The energy crisis, the growing interest in environmental issues and the contingency raised awareness of the *Esercito Italiano* in deploying capital to foster infrastructure modernisation. As a consequence, in 2019, the Italian Ministero della Difesa launched the *Caserme Verdi* project to revamp part of its infrastructures in terms of energy efficiency and rethink spaces.

The *Caserma Santa Barbara*, a military district of over **50 buildings** located in the *Forze Armate* neighbourhood in Milan, is one of these barracks. In this context, the previous commander of the barracks Valerio Golino, in 2022, launched the **Santa Barbara 4.0 (SB4)** project, envisioning the collaboration of the ASP group and a series of external partners to make the barracks one of the first **smart military districts** in Italy. From the beginning of 2023, the newly appointed Commander Di Stefano is carrying out Golino's commitment.

The role of the ASP team was twofold: on the one hand, to act as an **integrator**, supporting the militaries in the management of the project, fostering the collaboration and information exchange among external partners and between such partners and the militaries; on the other hand, to directly **propose and develop solutions**. Given the issues and needs of the barracks, the key focus areas of the SB4 project can be summarised as **urban rethinking, energy efficiency, and smart things**.

The final result is encapsulated in a **masterplan** and in a **3D model** of the barracks that can give a long-term vision of the project supporting the military and the external partners in continuing the various activities even after the end of the ASP project. The value we left to the militaries consists of ideas, proposals, projects and a network of relationships that we helped develop. These values will persist and be exported to the many other military districts facing the same challenges.

Key Words

Smart Military District, Urban Rethinking, Energy Efficiency, Smart Things, Connectivity



Physical 3D model of the Caserma Santa Barbara in scale 1:750.



LEGEND

- Barracks perimeter wall
- Gate
- Military entrance
- Entrance for external user
- Building
- Roof with photovoltaic panels
- Parking
- Parking with electric charging station
- Bicycle and scooter rack
- Streetlamp
- Impermeable surface
- Paved draining surface
- Paved draining surface accessible by external user
- Natural permeable surface
- Tree
- Multifunctional green area
- Multifunctional sports area
- Running track
- Gallop



**Project description
written by the
Principal Academic
Tutor**

The historical and prestigious *Caserma Santa Barbara* in Milan represents an ideal case study for a modern urban smart district with over 50 buildings, more than 1000 people between military and civilians living in the western area of the city, with also a horse regiment used for social and medical rehabilitation purposes, thus it is a complex system where security issues and civil society impacts cohabit in the same area with challenges for engineering and architectural design.

The SB4 project aimed to define new paradigms for Smart Districts considering a multi-layer design strategy where aspects of energy and environmental sustainability, data management, resiliency and liveability must be integrated from the beginning. This multi-purpose design approach was tested in the *Caserma Santa Barbara* test bed with the cooperation of the direct end-user and many stakeholders. New technology in renewable energy sources, energy efficiency, electric vehicles integration and storage was evaluated to better integrate them into the existing building areas, taking care of multidisciplinary aspects and external constraints in the domain of energy, water management, environment, architecture, security and ICT services.

Numerous benefits can be derived from these resilient Smart City districts. First of all, the most traditional benefits in low carbon footprint, penetration of renewable energy sources, augmentation of green areas, smart lighting solutions, and district heating, can advantage and give benefits to citizens and the environment. In addition, designing renovated urban spaces can improve the local functionality of districts inside future more sustainable cities considering a different and new integration of traditional military areas more opened to external users, with direct benefits for civil society in novel smart city applications with optimized use of resources.

**Team description by
skill**

The SB4 team consists of five members with different backgrounds, identifiable in two macro areas of study: energy and data-related engineering, and the other more urban and architectural.

In the realm of electrical and energy-related expertise, the team leverage the competence of Carolina Balducci, Lorenzo Zapparoli, and Simin Saadati. Carolina holds an MSc in Management Engineering with a specialization in Energy Management from Politecnico di Milano, bringing a deep understanding of the energy transition challenges and opportunities and managing energy resources efficiently. Lorenzo possesses an MSc in Electrical Engineering from the same institution, contributing valuable knowledge in electrical and energy systems and technology, and coding and programming skills. Simin, with her background in Mining Engineering from Politecnico di Torino, adds a unique perspective to the team, often bridging the gap between energy and resources.

On the urban and architectural front, our team benefits from the expertise of Cristina Cammaroto and Arianna Verga. Cristina holds a MSc in Architectural and Building Engineering from Politecnico di Milano, specializing in the design and construction of sustainable and efficient structures. Arianna brings her urban planning skills and knowledge of contemporary urban challenges, having earned an MSc in Urban Planning and Policy Design at Politecnico di Milano. Together, they bring a keen understanding of urban development, architecture, and the principles of sustainable design to our projects.

Throughout the whole project, the team's internal organization leveraged the heterogeneous backgrounds of the five team members. From a theoretical perspective, the team faced the initial phase of the project all together, defining the issues, the needs and the requirements as a unique team. Then, from October 2022 to January 2023, two sub-teams were created, one focusing more on **energy**-related pilot projects and one focusing more on **urban**-related activities. This has allowed the possibility of developing in-depth studies and actions in the two sub-themes. From January on, the team has started to work together again to adopt an overarching view of the barracks.

The collaboration of these two areas of expertise within our team enables us to approach projects with a holistic perspective, addressing both the technical and urban planning aspects. This diversity allows us to devise comprehensive solutions that consider the complex interplay between energy management and architectural design, making the SB4 team a formidable force in addressing multifaceted challenges.

Goal

The goals of the project can be split depending on their time horizon:

► **Short-term goals:** act as an **integrator**, supporting the militaries in the management of the project and fostering the collaboration and information exchange among external partners and between such partners and the militaries. Moreover, the second sub-goal of the first phase was the physical deployment, within the project duration, of a set of pilot projects which the militaries can use to assess the validity of some of the proposed solutions.

► **Long-term goals:** the long-term focus was to integrate the **urban, energy efficiency** and **connectivity interventions** generating feasibility studies for the proposed interventions. The final goal is to make Caserma Santa Barbara a sustainable smart district going beyond the duration and the budget of the project. Such studies are used by the militaries to assess the potential impact and convenience of different solutions, allowing them to decide which interventions to prioritize and to obtain funds. The strong multidisciplinary nature of the project required intensive coordination between studies for space review and those for energy and digital redevelopment.

The team defined its goals through the mean of specific and quantitative Key Performance Indicators (KPIs) identified for each focus area of intervention. They, in this phase of the project, can be correlated to part of the 169 targets of the 17 Sustainable Development Goals (SDGs) making the necessary approximations and considering the context in which we work: the Metropolitan City of Milan. Particularly, the goals relevant to the project are: 7 (Affordable and Clean Energy), 11 (Sustainable Cities and Communities), 13 (Climate Action) and 15 (Life on Land).

Understanding the problem

The creation of a smart district for the *Caserma Santa Barbara* urban military settlement can be classified as a wicked problem. The concept of a wicked problem stands for a complex decision concerning the future with unknown outcomes. It differs from normal problems because it is not characterised by the easy availability of data, has several stakeholders with different objectives, and has no negligible associated risks that could lead to radical changes in the subject under analysis. There is no single solution and consequently, no specific objective functions to minimise/maximise.

The lack of data on the state of the art due to the age of the building, and the coexistence of a series of stakeholders with different interests according to their area of belonging made this project a blank canvas at the beginning.

To **kick off** the project, the team adopted the following approach:

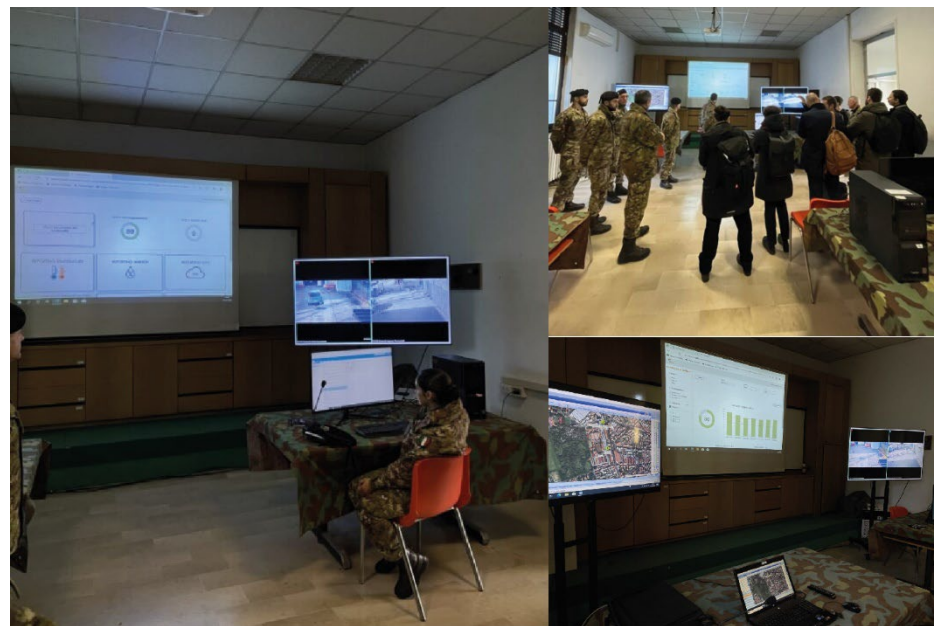
- It comprehended the ideas and goals of the final user, the barracks, and the primary existing partners via 1:1 interviews, site visits, meetings, and surveys.
- It comprehended the needs of the other stakeholders, such as the other Italian barracks, and the NATO Energy Security Concept among others.
- It identified new partners to be included in the project flow. When the SB4 project was initially launched, many key stakeholders who later played pivotal roles, were not yet part of the initiative, such as Comune di Milano, Enel X, Signify, MSCA, Eni Plenitude and others.

As a **second step**, the team has focused its efforts on the definition of the specific KPIs related to the urban sphere (to increase the liveability of both the residents of the barracks and the surrounding neighbourhood), the energy sphere (by analysing existing data and energy bills), and smart thing sphere (by engaging with the commander to understand data collection and analysis requirements).

After that, the team established the project's organizational structure, and a significant effort was dedicated to the theoretical planning and structuring of the activities. The main goal was to create a synergic workflow integrating all the partners involved and all the themes that characterize the project — urban planning, energy management, and technology integration.



Visit at the NATO Headquarters Rapid Deployable Corp Italy in Solbiate Olona (VA), May 2023.



Control room inauguration, March 2023.

Exploring the opportunities

From the very beginning of the project, the SB4 team understood the project opportunities were coming from the stakeholders' availability and initiatives. Therefore, the initial approach was to involve as many stakeholders as possible, coordinate them and align their goals with the SB4 goals. From the initial pool of partners, namely A2A Smart City, Cisco, Wi4B Motorola Solutions, Forestami and Vodafone, the team expanded the stakeholders map to several other actors.

The Santa Barbara 4.0 project creates countless business opportunities for its stakeholders. The main advantages are: (a) brand awareness, as industrial partners can install their devices in the buildings of the barracks aiming at showing their solutions for energy efficiency, security and increased liveability, (b) research and development, the spaces of the barracks can be exploited to install some POC of technologies still in the experimental phase, (c) synergies that can arise through the collaboration with the other companies in the SB4 ecosystem.

Generating a solution

Leveraging on the team skills and the stakeholders' availability, the team developed an overarching project aimed at redefining the Caserma Santa Barbara.

From the **urban** perspective, five KPIs have been reached. First, the **increase in the natural heritage by 34%** (11,300 sqm) has seen the development of areas with green surfaces and the strengthening of unexploited vacant spaces. Regarding the **annual increase of CO₂ absorbed by vegetation**, from 200 trees, the total number of 580 (+380) allows the barrack to increase their contribution to the absorption of CO₂ to a **total value of 8,700 kg CO₂-eq/year**. Closely linked is the third KPI related to the **enhancement in soil permeability**: at least 50% of the surfaces currently covered by concrete are made draining, using appropriate materials with this feature. Lastly, the goal of introducing slow e-mobility has led to the inclusion of exploitations that favour sustainable mobility. Up to a maximum of 130 parking lots with electric charging and 10 racks for bicycles and scooters have been added.

From the **energy** perspective the target reduction for Total Carbon Emissions (TCE), Total Energy Import (TEI) and Total Energy Expenses (TEE) was set by the militaries at 20%. The team proposed different solutions, such as a district heating system, a military energy community with a photovoltaic system, a boiler optimizer and adaptive lighting systems, among others. Considering the **TCE**, the state-of-the-art value is TCE = 1,352 tons of CO₂-equivalent, and the vision value, which considers all the proposed interventions, is TCE = 421 tons of CO₂-equivalent, corresponding to a **69% reduction in emissions**. The TEI, the state-of-the-art value is TEI = 7650 MWh, and the vision value, which considers all the proposed interventions, is TEI = 5581 MWh, corresponding to a **27% reduction**, resulting in a barracks that is considerably less dependent on external resources. Considering the **Total Energy Expenses (TEE)**, the state-of-the-art value is TEE = 1000 k€, and the vision value, which considers all the proposed interventions, is TEE = 633 k€, corresponding to a **37% reduction**.

From the **smart things** perspective, the team installed several **smart objects** and the **creation of one control room**. The team managed to install 6 smart devices, namely (1) the BRAIN_{by Tree Solution} - the boiler optimizer -, (2) the Smart Meter, (3) the smart lighting system by Wi4B, (4) the A2A Air Flow - the air quality detector -, (5) the smart bins and (6) the smart parking sensors. Moreover, thanks to the work of the team many other smart devices are in the pipeline of the barrack. To provide a couple of examples, the team introduced the barracks to Signify, who showed its interest in installing PoC for smart lighting for internal areas, and to BeCharge x EniPlenitude, who demonstrated their willingness to install charging points for EVs. Moreover, the team inaugurated the barrack control room. Today, the Caserma Santa Barbara has an operating control room that focuses on two main pillars, energy and security. Regarding the security system, a software-based security system, utilizing Avigilon technology, includes surveillance camera replication, license plate recognition, and a new access control system (currently in the process of installation). For what concerns the energy system, the control room is utilizing A2A's CityEye platform (linked to the A2A Air Flow) for displaying environmental sensor data in the Legnano Hall and in one of the barracks rooms. Moreover, it displays the data coming from the Smart meter and the BRAIN_{by Tree Solution}. The next steps will be to integrate data from the other already installed smart devices, i.e. the smart lighting systems, and the others to come, i.e. the e-bike and scooter charging station.

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