

Architecture of the urban pavements in Rome. A case of study of Multi-scale and digital approach for an ecological transition

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Abstract

The issue of urban quality of public space has become a significant concern in city management strategies, as evidenced by international and European policies. A research project conducted by Citera-Sapienza University, funded by the Municipality of Rome, aimed to develop guidelines and tools to enhance the quality of urban pavements. The study posited that the quality of cities is inextricably linked to the quality of their streets, pavements, and squares. The complex urban structure and historical layers of Rome provide a unique opportunity for experimentation with various approaches to urban planning and management, with the ultimate goal of achieving urban quality. The study identified innovative solutions for different types of paving, including for vehicles, pedestrians, cyclists, and trams, as well as parking areas. In light of the city's diverse spatial contexts, the study sought to contribute to the urban quality and character of Rome's streets by elucidating its distinctive typological and morphological attributes.

Keywords: *urban quality; technological innovation; digitalization; sustainability; management of the built environment.*

1. INTRODUCTION

The maintenance and reconfiguration of public space is influenced by a number of socio-economic and cultural factors. Changes in the lives of European citizens, such as pandemics, wars, economic instability, green policies and the rising cost of raw materials, are determining new configurations in urban space. For example, the rising cost of petrol and the advent of e-mobility are influencing urban mobility, with more and more people using electric bicycles and scooters. However, this transformation has not been planned in a unified and conscious manner, leading to interference in urban mobility. The COVID-19 pandemic has also had an impact on the urban street, with the closure of parks and an increase in outdoor businesses. Restrictions on vehicular traffic to reduce carbon dioxide emissions, together with the need to develop rail transport, are leading to further changes in public space. These changes, which are part of the metamorphosis of contemporary life, are bound to persist. These changes, which are largely unplanned, are only one aspect of the broader challenges associated with the metamorphosis that contemporary life is undergoing. They are likely to persist. In light of this, it is crucial to explore ways to streamline and mitigate the impact of these changes. This entails understanding how to structure and streamline the process of change, as well as proposing alternative scenarios for the city of Rome. These scenarios should aim to enhance the city's resilience and sustainability, while reducing the negative effects of mobility, sociality, and trade.

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The definition of the '*Linee guida e strumenti operativi per il miglioramento della qualità urbana delle pavimentazioni stradali carrabili, ciclabili e pedonali degli spazi pubblici Roma Capitale*' was informed by the study of the principal element of the research, namely the roads. The term "street" is derived from the late Latin locution "via strata," which refers to a ballasted road. This term is derived from the Latin past participle "stratus," which is derived from the verb "sternere," meaning to lay down or pave. This definition is well expressed in its encyclopaedic definition: "long strip of ground made flat and firm, which the ancients used to pave to go from place to place." The term "way" is used as a synonym for the word "road," which in turn is derived from the Latin term "via." This term, in turn, is derived from the verb "vehere," which means to carry or to lead. In contrast to the word "road," the word "way" is used to describe a series of actions that occur in different contexts. This etymological reading suggests that the concept of concentrating research on the aggregative function of the street in the strict sense should be extended to encompass its role as a public space that is not solely intended for transport and movement from place to place. The street, which was originally a paved surface characterised by its materiality, has developed into a social and commercial hub, while still fulfilling its primary function of allowing pedestrian and vehicular movement.

The study of the road fabric at the urban scale, which determines the urban network, provides the foundation for understanding the settlement fabrics, which can be considered the negative of the road. These settlement fabrics comprise the morphological composition of urban planning studies in the broadest sense. The research was conducted at a smaller scale, focusing on proximity, to investigate in detail the spatial and perceptual configurations. The most appropriate tools for this study were identified as the cross-section, the plan and axonometry. In order to achieve this objective, a selection of urban planning treatises developed in the European context at the turn of the 19th and early 20th century has been chosen, with a particular focus on aspects related to the study of the street. This is because the authors selected were in part concerned with the observation of urban transformations, generated by the advent of modernity and the invention of the automobile, which have been significant factors in the organisation of the road system and the public space of social aggregation. Alternatively, they were directly concerned with the transformation of urban agglomerations.

2. MATERIALS AND METHODS

The research hereinafter presented commences with an analysis of the current state of good practices employed in the qualification of public spaces within compact, stratified, modern and contemporary cities. The study developed a typology of the compositional, functional, technological and material elements that constitute the city's street layout. In fact, the street plays a role in structuring and characterising the urban morphology in its historical complexity and in relation to the urban fabrics, which in turn influence the settlement typologies. These typologies can be categorised into three main areas:

- the street;
- the square;
- the green system.

The study of these complex systems has been articulated by breaking down the final elements through which they are concretely configured. As an example, the road, in addition to being classifiable in terms of urban planning and traffic, is made up of a set of concrete elements that can be gradually broken down: urban wings, trees, carriageway, lane, pavement, pavement, verge, drainage, manhole cover, etc. The considerable overlap between the various urban elements with different functions suggests that the architectural design of the street should be based on criteria that are always up-to-date and sensitive to the definition of quality elements of public spaces. These elements play a crucial role in the lives of citizens [1] and concern a multiplicity of aspects, including the theme of urban pavements. This is part of a broader theme of the quality of public space [2], since the street is the

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soul of the city [3]. There is no doubt that through a partial reading of the city by stratigraphic levels, the layer constituted by urban paving – streets, pavements, squares – has an essential function in contributing to the quality of urban life. This element is the foundation of urban decorum and furnishings and interweaves the physical component with the functional and usage component of the city in a continuous state of transformation. The research aims to return to tradition, to the ‘genius loci’, to the sense of community and to the real inclusion of the citizen in civic life, inspired by the principle that the human being as an entity has not changed in its intrinsic nature throughout history. While customs, technologies, and production processes may evolve over time, the essence of humanity remains constant. The innermost tensions and needs of humanity, in all their complexity and universality, have remained unchanged throughout history.

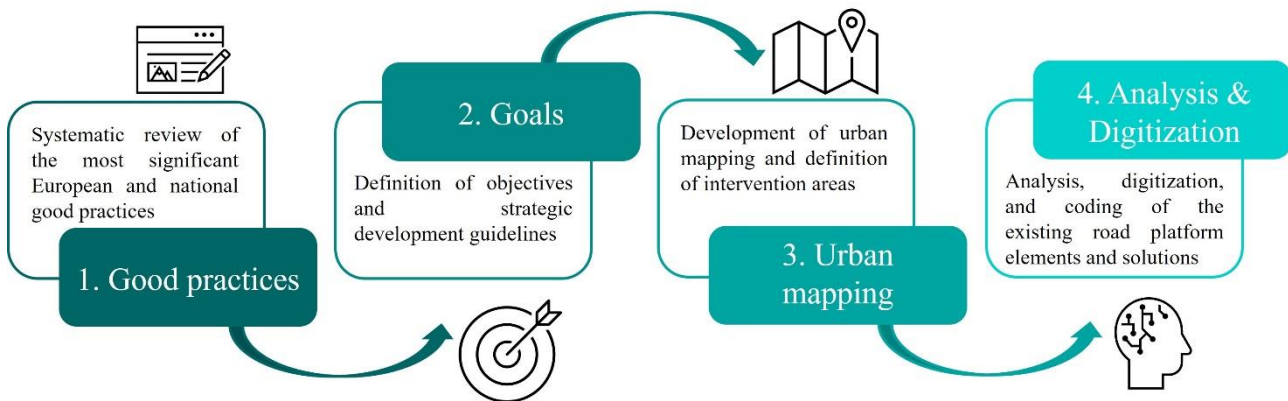


Figure 1. Methodology flowchart for the development of guidelines and tools aimed at enhancing the quality of urban pavements.

The methodology to develop guidelines and tools to enhance the quality of urban pavements is based on 4 main steps (Figure 1):

- 1st step: systematic review of the most significant European and national good practices;
- 2nd step: definition of objectives and strategic development guidelines based on the study of the state of the art at the international and national levels;
- 3rd step: urban mapping;
- 4th step: analysis, digitization, and coding of the existing road platform elements and solutions.

2.1 State of the art and good practices

The authors selected for this study were chosen based on their contributions to the field of urban planning. Joseph Stubben's treatise, "Urban Development" [4] is a comprehensive study of urban planning in Europe, including numerous planimetries and road sections of cities across the continent. Many of these cities are located in our study area, specifically in the Iberian Peninsula. Of particular interest in this author's work are the graphic aspects, namely the use of the section as the most effective tool in the representation of the road platform in relation to the settlement tissues, and the quality of the representation in general, which lends itself excellently to the description of the road. Furthermore, the author implements a comparative vision in the vast sampling of roads analysed. The second treatise we studied was Camillo Sitte's "The Art of Constructing the City" [5], in which the author deals mainly with the square, the public space par excellence. He focuses a great deal on the perception of spaces and the relationship between the urban backdrop and the open space, between the road network and these nodes, as well as the material composition of the compositional elements. This approach is significant and interchangeable for the study, albeit of linear rather than punctual elements. These elements present some common characteristics in the uses of the street, some similar

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elements in the urban scene. These include urban wings, paving, monuments, fountains, kiosks, commercial activities, verges, interstitial greenery and albedo. The third author we have discussed is Eugene Henard [6], whose work is entitled 'Study on the Transformations of Paris'. In this text, Henard presents a series of futuristic scenarios regarding the urban and road layout for Paris. These scenarios are presented in a dystopian key, but they are not so distant from transformations that have actually taken shape in the composition of roads within consolidated cities in the European sphere. The fourth author analysed in the context of the development of the research is Ildelfonso Cerdà, who developed the plan for the urban transformations of Barcelona [7]. Cerdà paid particular attention to the conformation of the street from multiple points of view, in an exhaustive and even ironic way, in relation to the current and future transformations of the street in a broad sense. He dedicated a large chapter to the street within his treatise.

A systematic review of the most significant European and national good practices was also conducted to align knowledge with the state of the art on the specific topic. The good practices selected as most relevant at European level were the cases of Amsterdam and Barcelona, while at national level the cases of Milan and Bologna were deemed to be of particular interest. The selection was based on two criteria. The first concerns the period between 2011 and 2021, during which the most advanced measures in the field of urban sustainability were adopted by European cities. The second criterion considered the extent to which the policies adopted paid attention to the degree of stratification of the urban fabrics analysed and in particular to the relationship between the historic centre and the expanding city. In considering the cases in which the policies adopted paid attention to the degree of stratification of the urban fabrics analysed, and in particular to the relationship between the historic centre and the expanding city, it is evident that these variable conditions contribute to determining the objectives of standardising solutions. In the case of Barcelona's Superilles programme [8], which has become the model for the transformation of the streets of the entire city, the city council has identified the new 'panot for the 21st century' as a potential solution [9]. The first century of the programme preserves its value as an intangible heritage, while incorporating innovative solutions and technologies that make it more sustainable for the future. This sustainability is based on the composition of materials and manufacturing processes, reuse and recyclability.

In the context of Europe, it is notable that cities that have long favoured the development of soft mobility systems include Amsterdam. This city has adopted a method known as the 'Puccini method', which has been in use since 2021. This method is a manual that standardises solutions for the design of public spaces, including streets, squares and gardens. The method has adopted a set of sustainability standards, which must be met by every project and subsequent contract. In addition, this set of urban policies contains a mapping of pavements, a mapping of the lighting system and a mapping of the main structure of urban vegetation systems. Amsterdam's design guidelines can be found in two manuals that contain the technical details of the urban policies, including drawings and a list of the materials used. The *Handboek Groen* [10] provides guidance on the planning and management of greenery, while the *Handboek Rood* [11] offers advice on the design of urban elements.

It is also worth noting the city of Paris, which has developed a digital mapping model, created by the APUR Agency, for use from 2022 onwards by the Administration for the management of interventions on the road network. Additionally, the city has produced an *Atlas du Mobilier Urbain Parisien*, which is intended to assist in the planning of its maintenance. The relevance of the Paris case can be attributed to the mapping and systematisation activity carried out over a vast area on which highly articulated structures are triggered, as well as to the generation of an online platform, free and fully accessible, which demonstrates the replicability and transferability of this type of operation to different contexts. In the national context, the "Manuale dello spazio pubblico - Linee guida per la progettazione" [12] represents a flexible tool for the design of public spaces. In a recent resolution, the Municipality of Milan joined with *Milano Città 30* to set the speed limit in urban areas

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at 30 km/h as of 1 January 2024. This resolution anticipates the possibility of setting 50 km/h limits on some main roads after that date, a course of action that has been taken by Paris and Brussels. The Municipality of Bologna [13] also initiated the process of becoming City 30. This was achieved through the formulation of a document outlining the principles of urban quality. This document provided guidance on the design and implementation of open spaces for public use, including new urbanisation and redevelopment projects. The aim was to clarify and better interpret the concepts of quality and public use, in accordance with the prevailing regulations.

2.2 Definition of objectives and strategic development guidelines

In the context of urban public spaces, road pavements constitute the surface layer and are subject to continuous maintenance due to wear and tear and to technological and material upgrades to counter disruptive issues regarding environmental sustainability. In the compact city, the maintenance of pavements and their replacement is not a simple and interference-free process since the image and material consistency of these determine the image of the city's public spaces in their historical and material connotation rooted in the collective imagination. The surfaces of these spaces must respond to multiple needs, including those of a perceptive-landscape and historical-iconographic nature, in order to guarantee high levels of safety, well-being, usability and liveability. Therefore, the urban context and the functional requirements to which the pavements must respond according to the type of use that characterises them, necessarily influence the choice of morphology, material and installation. In the case of resurfacing an urban pavement, it is desirable, where possible, to preserve the site's construction traditions, respecting its material and chromatic characteristics, taking into account climatic and lighting conditions and the needs for comfort, efficiency and sustainability.

Careful road design can make a significant contribution to mobility, the environment, and human health. This can be achieved through the planting of trees, the adoption of specific materials to improve the microclimate, reduce air and noise pollution and increase the resilience of the urban system [14]. The road pavement construction sector is constantly evolving to optimise performance levels and durability. The following are some of the goals that can be achieved through careful road design [15]:

- Reduction of air pollution;
- Reduction of noise pollution;
- Reduction of heat island;
- Increased water drainage;
- Increased energy efficiency;
- Increased perceptive quality.

The protection of the city's historical features through the replacement of pavements with more efficient and sustainable materials from an economic and environmental impact point of view is a complex process. On a national and international (European) level, these activities have been organised and implemented through maintenance plans developed mainly in the technical sphere by the local administrations of the different cities. Noteworthy are the experiences of Barcelona, Amsterdam and Paris in the European context; of Milan and Bologna in the national context. The Experimental Study for the Definition of Guidelines and Operational Tools for the Improvement of the Urban Quality of Roadway, Bicycle and Pedestrian Pavements in the Public Spaces of Roma Capitale, prepared by the Interdepartmental Research Centre Territory Building Restoration Environment (CITERA), is a pertinent example of good practice within this context.

2.3 Urban mapping

The increased attention given to the user, the qualitative dimension of accessibility and usability of movement spaces, the heterogeneity and extent of urban contexts, and the plurality of morphological

characteristics of urban settlement fabrics require a new methodological approach for identifying standardized typological and constructive solutions aimed at meeting the needs of the diverse and resilient ecosystem. The innovative aspect of the research lies in the systemic approach that we have adopted in studying pavements. This approach differs from the purely viability-based approach that is more commonly used in modern interventions, which do not relate to the formal city in its morphological peculiarities. In an era strongly influenced by a prevailing globalisation, we believe that experimentation through the conjugation of crucial issues such as sustainability, environmental impact, reduction of heat islands and soil permeability must be integrated with the study of identity characteristics that cannot be divorced from the use of traditional materials in relation to the historicity of the fabrics. This is necessary to create new solutions that improve living conditions for citizens and preserve those characteristics proper to each settlement fabric. The conservative approach is innovative, through the original use of classic elements such as stone, which can be integrated into spatial configurations of permeable pavement fields. This approach has the potential to significantly reduce the environmental impact of total cementification, while preserving the aesthetic and formal features that constitute the collective recognition of the city by its inhabitants. The research in question therefore proposes a meticulous, cross-disciplinary approach, in continuity with the urban planning vision linked to the formal aspects of the city and in contrast with a mere viability approach typical of the post-war period and the advent of the automobile, which is highly reductive, and impoverishing compared to the richness of a formalistic approach.

The challenge in achieving this objective lies in identifying a cultural value that enhances it, as the utilisation of new technologies is employed to enhance the living conditions of users and to guarantee levels of eco-sustainability without compromising the identity imparted by the composition and materiality of the elements. To define a series of standardized solutions, it is essential to conduct a series of large-scale studies, oriented towards a critical overlap of different planning tools that can influence programming and management choices related to urban pavement characteristics. To the tissues of the regulatory plan, which identify homogeneous parts of the city, specific tools such as the general traffic plan, the urban sustainable mobility plan (PUMS), and the urban heat island map can be overlaid. Urban-scale studies must be based on a specifically elaborated basis, capable of expressing the connotation of the morphology of the city's environmental system.

2.4 Analysis, digitization and coding of the existing road platform elements and solutions

Another innovative aspect of the research is the instrumental one, namely the use of digital programmes. Given the extent of pavements and the heterogeneity of the constituent elements of the road platform in modern cities, it is deemed useful to establish a classification and a unique coding system to identify the main typologies and corresponding materials of urban pavements, as well as the interferences/nodes among the constituent elements of the road platform. The encoding of the constituent elements of the road platform serves as a starting point for the subsequent modeling of objects in the BIM environment - Building Information Modeling, to which specific technical specifications (such as materials, stratigraphy, dimensions, weight, color) and related laying and maintenance interventions can be associated to optimize the management system. The development of the case studies was carried out entirely within the BIM environment, which proved to be highly useful for the extrapolation of the graphic designs and the abacuses related to the quantities for computation [16-17]. Furthermore, software was employed for the visualisation and processing of images and renderings to simulate mood boards with the material characteristics of the pavement surfaces and road elements (driveway and pedestrian ramps, verges, tree beds, drains, manholes). 3D modeling software has been used to assess the microclimate and ensure sustainable and resilient urban design through innovative solutions aimed at enhancing thermal comfort while mitigating the heat island effect [18].

3. THE CASE STUDY OF THE CITY OF ROME

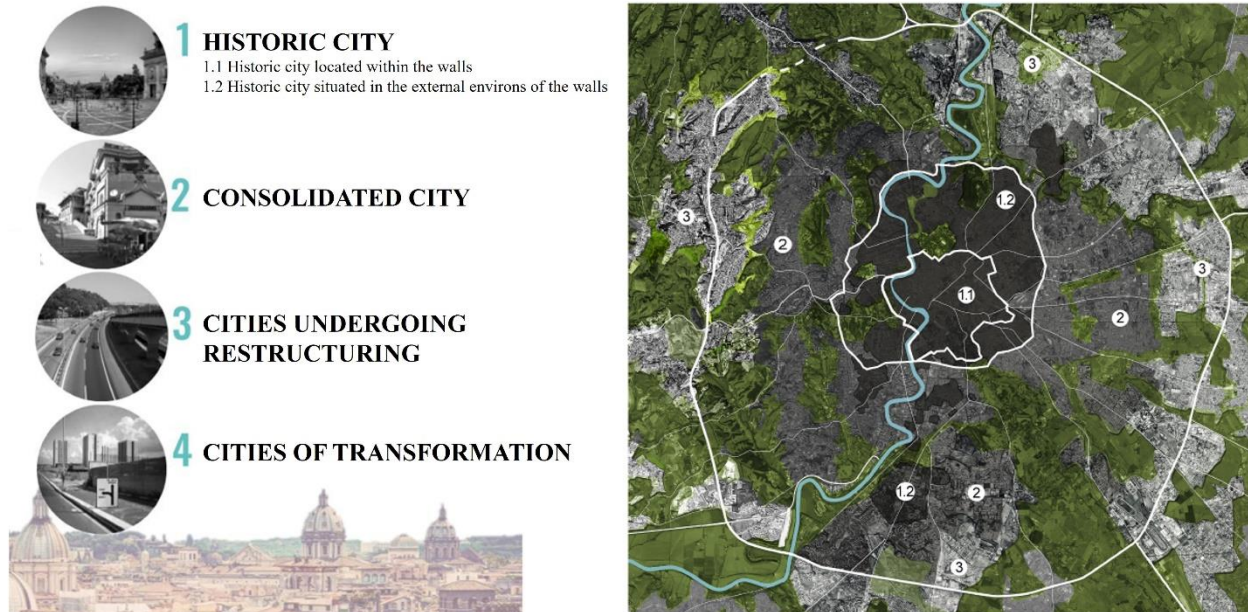


Figure 2. Division of the city into four main intervention contexts.

The investigation of the most efficacious methodologies delineated above revealed the pivotal elements employed to formulate the directives. In accordance with the overarching sustainability objectives, pioneering solutions were identified for vehicular, pedestrian, bicycle, and tram pavements, and those for car parks. Furthermore, in accordance with the strategic framework of existing urban plans, a subdivision of the city into four principal intervention settings was proposed: the historic city located within the walls; the historic city situated in the external environs of the walls; the consolidated city; and the city that is currently undergoing restructuring (Figure 2).

The articulation of the city of Rome by fabrics represents a genuine revolution because it acknowledges the diversity and typological/morphological complexity of the different parts that it is composed of. Over the course of its millennia-long history, this has resulted in the emergence of settings that differ from one another. It is therefore essential to discern these settings if the city's many identities and specific features are to be valued and preserved. It was, consequently, unavoidable that a study aimed at enhancing and improving the quality of the road space should make reference to the plurality of the typological/morphological articulation of the body of the city.

This was particularly the case in the specific instance of the mapping of Rome's road network, which required the provision of a framework that would enable the different spatial situations to be given shape and urban quality. Due to the extensive nature of pavements and the heterogeneous composition of the road platform, a classification and univocal coding were developed to identify the primary typologies, the corresponding materials for urban pavements, and the nodes in the BIM environment (Figure 3).

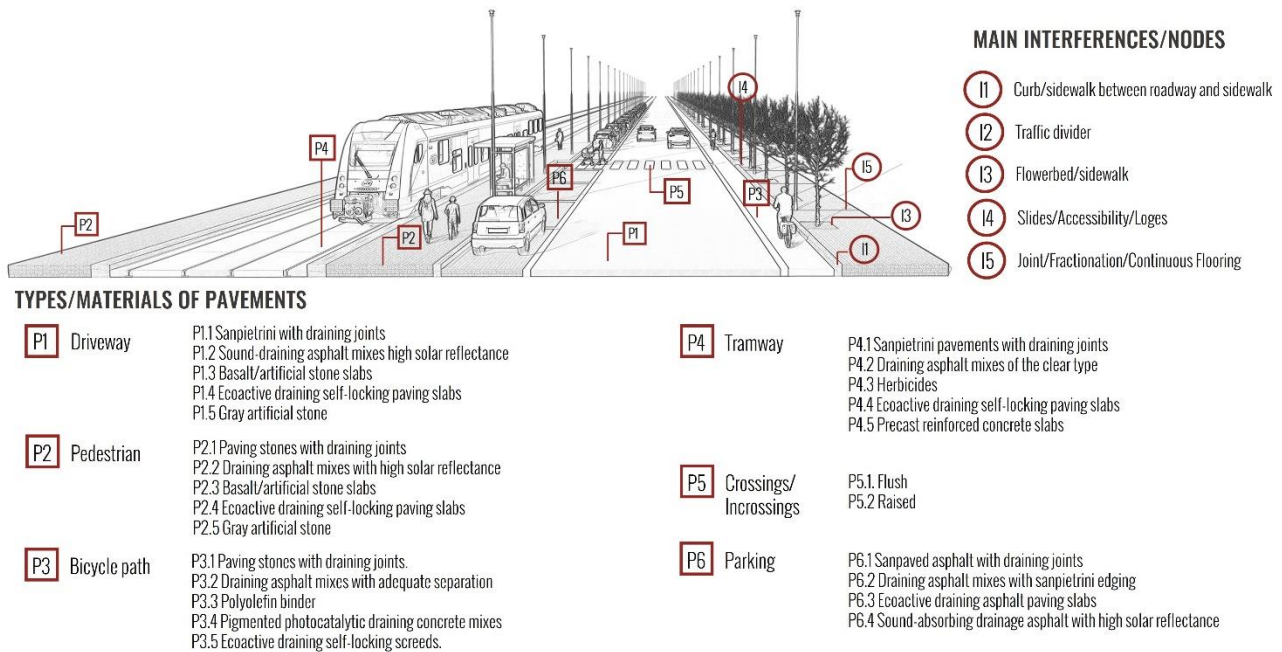


Figure 3. Coding of the existing road platform elements and solutions.

The effects on microclimate of the planned solutions for improving the urban quality of roadway, bicycle and pedestrian pavements in public spaces in Rome were tested using three-dimensional simulation software. Such software made it possible to measure the physical interactions that are generated within an urban context, consisting of open spaces (man-made or natural) and buildings, and to describe through specific parameters (temperature, humidity, wind speed, etc.) and outdoor well-being indices (Physiological Equivalent Temperature – PET, Urban Thermal Climate Index – UTCI, etc.) the microclimate (Figure 4-5). All of the activities involved in the research work have converged in the development of integrated digital models in the BIM sphere for the applied systematisation of new technologies and the prudent use of traditional materials in a sustainable manner, with particular attention to soil permeability.

This is achieved through the design of contextualised road sections in relation to the settlement fabrics. The methodology employed in the study involved considering the various options for pavement replacement in relation to urban fabrics and the building types that characterise them, with particular attention paid to urban historical-identity features. Starting from concrete cases and therefore from the detail, a typological classification was carried out in a standardised abacus (verges, drains, tree cups, manholes, paving surfaces).

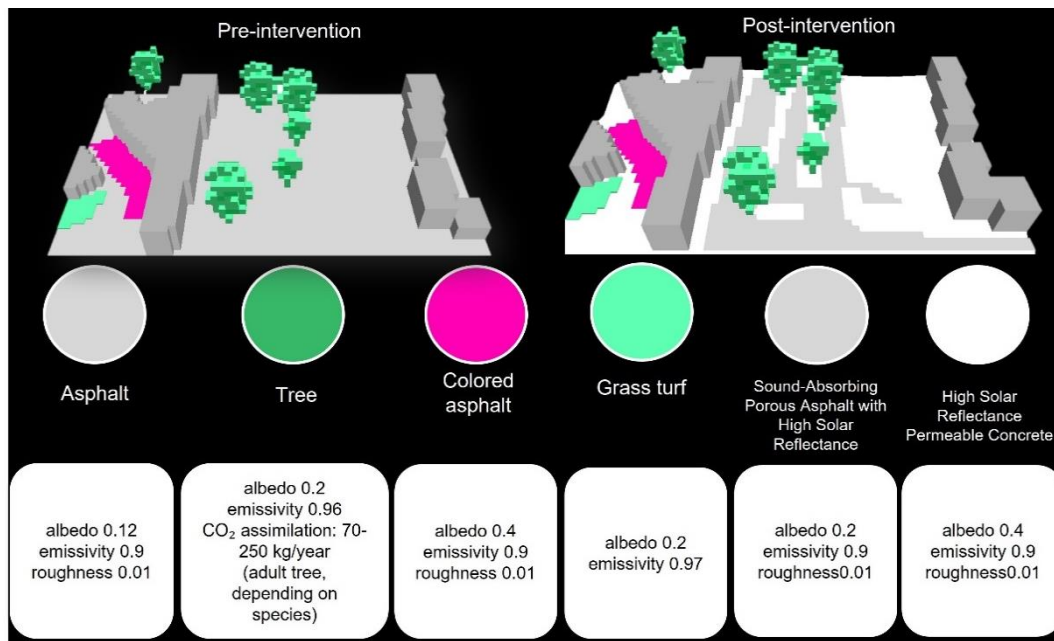


Figure 4. Example of the input data for the actual state and post operam simulations

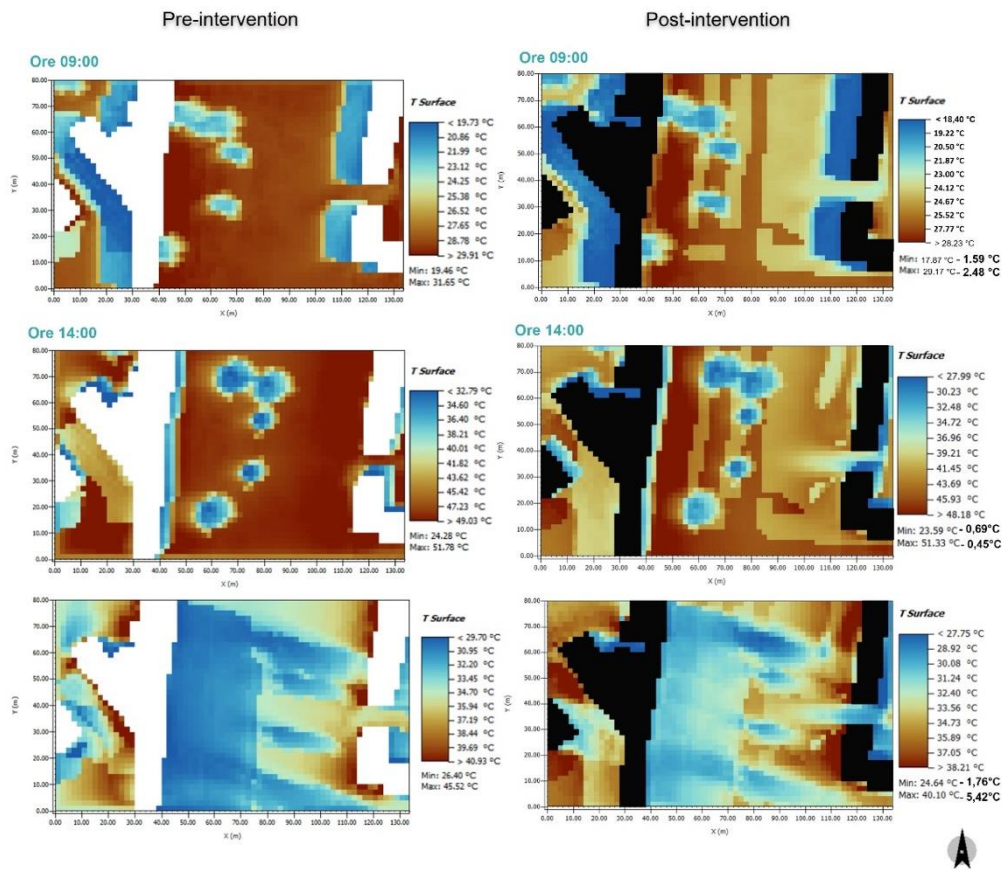


Figure 5. Results of simulations for verifying pavement surface temperatures conducted on 14/07/2023

The following section presents a summary description of the activities developed within the framework of the research project:

- The initial phase of the project, which was conceptual in nature, involved the systematic documentation of exemplary practices from both domestic and international sources. This was achieved through the use of textual cards and drawings.
- The second phase of the project involved the study and classification of urban fabrics through the identification and mapping of urban fabrics at an urban scale. This was followed by the development of projects for exemplary street sections of the city of Rome for the various settlement fabrics.
- The third synthesis phase resulted in the standardisation of the solutions in an abacus of the paving surfaces and road elements (pedestrian and vehicular ramps, kerbs, drains, tree beds) (Figure 6-7-8). Additionally, mood boards were created to simulate the material combination through the development of renders, thereby making explicit the textures and thus the aesthetic-formal result of the solutions.

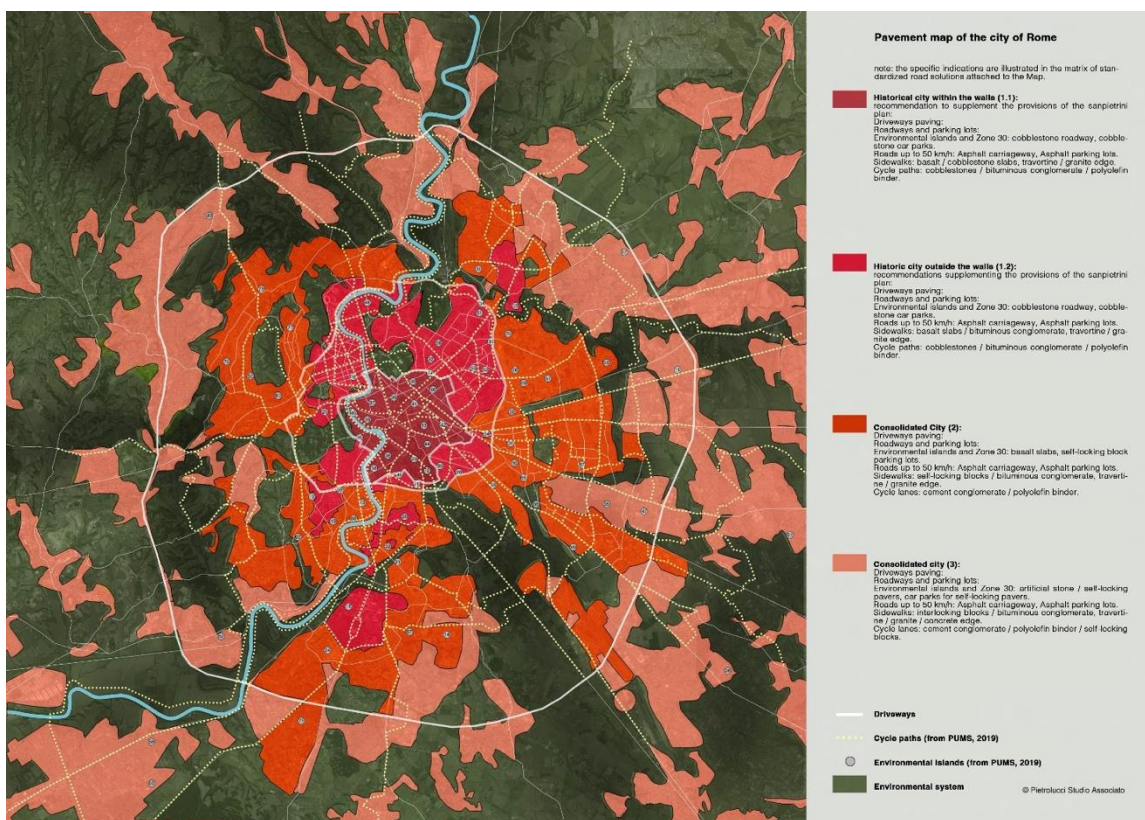


Figure 6. The map of road pavements in the city of Rome (2023): it attributes a set of materials and qualities to each of the road pavements. (source: Municipality of Rome).

4. CONCLUSION

The proposed research is characterised by its novel and original approach to the systematic integration of diverse digital tools to support regional management and facilitate the attainment of objectives pertaining to ecological transition and sustainable development, in accordance with both the fundamental tenets of the PNRR – namely, environmental sustainability and digitisation.

The system allows the creation of a dynamic and constantly updated road classification system, beginning with digital cartography processing and updating in open format and progressing to the scale of technological details through a single click transition to BIM [19] vision and logic. Further,

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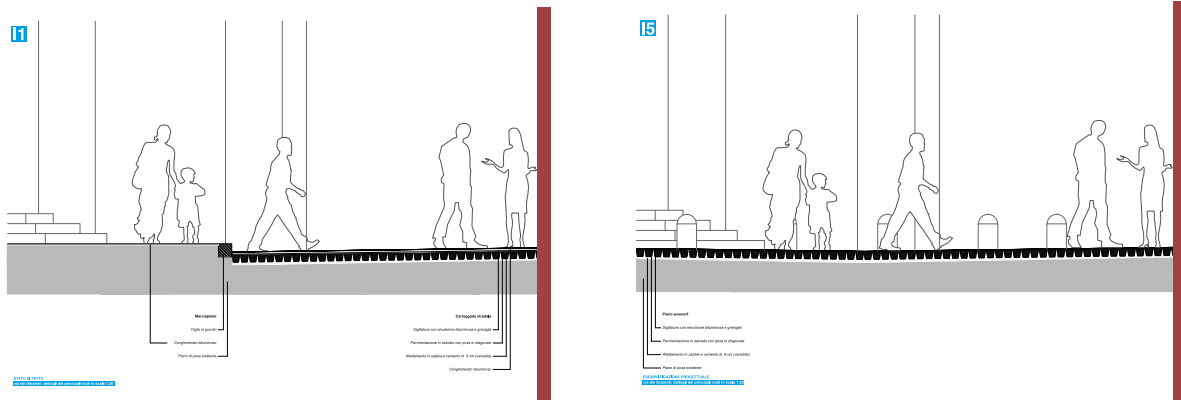
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it permits the retrieval of detailed information on architectural, interior, and infrastructural components at the requisite scales. Potential avenues of inquiry for activities aimed at enhancing the quality of urban areas may encompass the integration of sophisticated technological advances, such as AI and the IoT [20], which offer a novel avenue for promoting the implementation of ecological and digital transitions, a novel form of "sustainable innovation."

The development of digital technologies offers useful tools to facilitate planning, execution and maintenance procedures, which are essential for improving the safety and sustainability of road infrastructures [21]. One such example is the creation of a digital representation of a physical asset, which may include data such as historical conditions and relevant data. This digital duplicate can be employed in the implementation of predictive maintenance, which is of significant importance for the improvement of environmental, economic and social sustainability in accordance with the strategic objectives of the European policy framework.

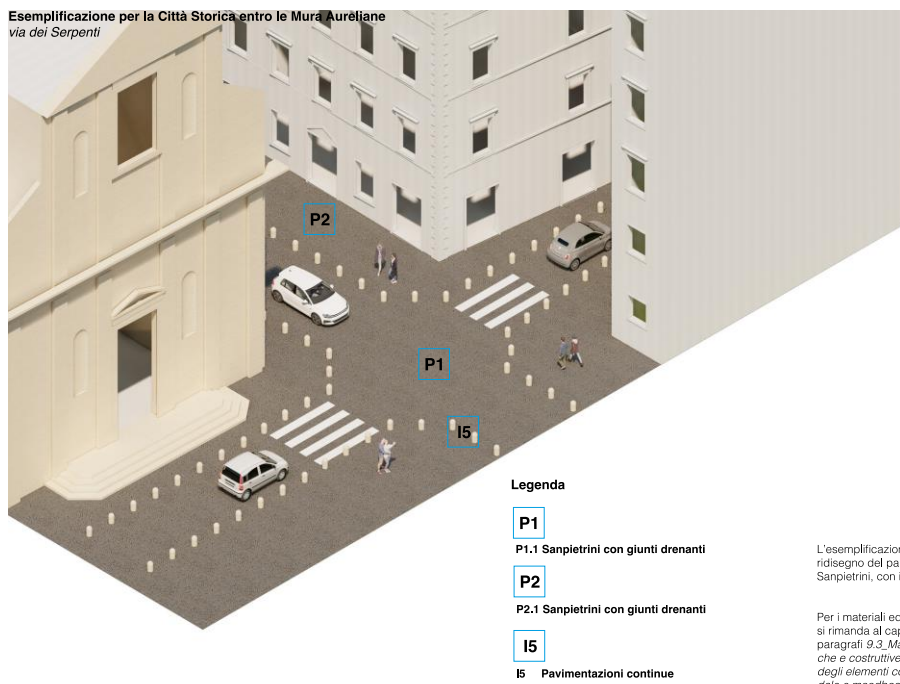
AMBITO DI PROGETTO ESIGENZE	PAVIMENTAZIONI CARRABILI				PAVIMENTAZIONI CICLO-PEDONALI				PAVIMENTAZIONI LINEE TRAMVIARIE		CIGLI/BORDI		LOGES				
	CARREGGIATA		PARCHIEGGIO		PISTE CICLABILI		MARCIAPIEDI										
1. Città storica 11 Città storica centrale entro la muria	Sarpietrini con giunti drenanti	Conglomerato bituminoso drenante fonosorbente elevata riflettanza solare	Sarpietrini con giunti drenanti	Conglomerato bituminoso drenante con bordatura in sarpietrini	Sarpietrino con giunti drenanti	Conglomerato bituminoso drenante con adeguata separazione	Legante poliolefinico per conglomerati e asfalto	lastre in basalto / Pietra lavica ²	Sarpietrini	Sarpietrini	Conglomerato bituminoso drenante di tipo chiaro	Travertino	Granito	Elementi in pietra o agglomerato cementizio grigio sp. 33 mm			
12 Città storica dell'espanso oltre extra muria	Sarpietrini con giunti drenanti	Conglomerato bituminoso drenante fonosorbente elevata riflettanza solare	Sarpietrini con giunti drenanti	Conglomerato bituminoso drenante fonosorbente con bordatura in sarpietrini	Sarpietrino con giunti drenanti	Conglomerato cementizio fotocatalitico pigmentato	Legante poliolefinico per conglomerati e asfalto	lastre in basalto / Pietra lavica	Conglomerato bituminoso drenante elevata riflettanza solare ¹	Sarpietrini	Conglomerato bituminoso drenante di tipo chiaro	Travertino	Granito	Agglomerato cementizio grigio sp. 33 mm			
2 Città consolidata	lastre in basalto / Pietra lavica	Conglomerato bituminoso drenante fonosorbente elevata riflettanza solare	Mazzoli autobloccanti drenanti ecoattivi ³	Conglomerato bituminoso drenante fonosorbente elevata riflettanza solare	Conglomerato cementizio drenante fotocatalitico pigmentato	Legante poliolefinico per conglomerati e asfalto	Pietra artificiale grigia	Conglomerato bituminoso drenante elevata riflettanza solare	Sarpietrini	Irrobbita	Conglomerato bituminoso drenante di tipo chiaro	Travertino	Granito	Agglomerato cementizio grigio sp. 33 mm			
3 Città da ristrutturare 4 Città della trasformazione	Pietra artificiale grigia ²	Mazzoli autobloccanti drenanti ecoattivi ³	Conglomerato bituminoso drenante fonosorbente elevata riflettanza solare ¹	Mazzoli autobloccanti drenanti ecoattivi	Conglomerato bituminoso drenante fonosorbente elevata riflettanza solare	Conglomerato cementizio drenante fotocatalitico pigmentato	Legante poliolefinico per conglomerati e asfalto	Mazzoli autobloccanti drenanti ecoattivi ³	Mazzoli autobloccanti drenanti ecoattivi ³ in pietra artificiale grigia	Conglomerato bituminoso drenante elevata riflettanza solare	Mazzoli autobloccanti drenanti ecoattivi ³	Irrobbita	Conglomerato bituminoso drenante di tipo chiaro	Travertino	Granito	Calcestruzzo	Agglomerato cementizio grigio sp. 33 mm

Figure 7. Matrix of standardised typological and construction solutions – materials (source: Municipality of Rome).



a)

b)



c)

Figure 9. Examples of a technical data sheet from the BIM environment, for Via dei Serpenti in Rome. a) cross section of the current state; b) cross section of the design state; c) axonometry of the proposal design. (source: Municipality of Rome)

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