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LONG ABSTRACT

Evaluating the effects of Tax incentives and surcharges on Vehicle Purchases and Emissions: Empirical evidence from Italy

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Keywords: air pollution; greenhouse gas emissions; road transportation; feebate scheme; environmental policy; vehicle taxation

1 Introduction

Road transportation represents a non-negligible component of greenhouse gas (GHG) emissions responsible for climate change (IPCC, 2023) , accounting for almost a quarter of Europe's GHG emissions (24% in 2020) and it is the main cause of air pollution in cities (*European Commision, 2023*).

Policymakers try to implement taxations schemes to address this environmental issue, but encounter difficulties in navigating such a complex system of externalities characterized by the interaction between environmental externalities with social and economic externalities (Parry et al., 2007; Santos et al., 2010).

Moreover, when choosing and implementing these tax schemes, policymakers should consider that the results of previous policies are mixed and sometimes undesirable (Ciccone, 2018; D'Haultfœuille et al., 2014; Givord et al., 2018; Gruenspecht, 1982; Hennessy & Tol, 2011; Mandell, 2009). It is, therefore, necessary to consider these unintended effects when deciding to implement these policies (Bergantino et al., 2021). One innovative policy instrument, the *feebate* system, offers incentives for the purchase of low-emission vehicles while imposing fees on high-emission ones (D'Haultfœuille et al., 2014; Verboven, 2014).

2 Feebate

The *feebate* system represents a market-based scheme in which the vehicles exceeding a certain fuel consumption threshold are subject to charge, while those below that threshold receive discounts (Greene et al., 2005).

One of the notable advantages of this scheme is its potential for revenue neutrality. The rebates provided to vehicles below the threshold can be offset by fees levied on vehicles exceeding it. This characteristic allows for the implementation of the policy without being perceived as a form of taxation. Furthermore, feebate schemes offer ongoing incentives for enhancing fuel economy, particularly as new technologies emerge (Gordon & Levenson, 1989; Greene et al., 2005). These reasons make it extremely important to carefully evaluate the implementation of such policies.

The car market is one of the most relevant markets in Italy accounting for 6.2 % GDP (Tomo, 2021). Within the Italian budgetary Law for 2019[1], two distinct fiscal measures defining a *Bonus-Malus* system

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[1] *Law 30 December 2018, n. 145*

aiming to reduce atmospheric pollution and promoting decarbonisation in the vehicle sector was adopted.

Table 1. Feebate Scheme March 2019 (Without Scrapping)

CO_2(g)/km	Price Variation
<= 20	-4000
>20; <=70	-1500
>70; <=160	0
>160; <=175	+1100
>175; <=200	+1600
>200; <=250	+2000
>250	+2500

3 Methodology and Data

To evaluate the effects of the policy, we refer to the Rubin Causal Model (RCM) which compares the outcome of the intervention with what would have occurred in the absence of the intervention (Imbens & Rubin, 2015; Rubin, 1974).

However, the challenge arises from the absence of a valid control group, given that the policy affects all units simultaneously (Cerqua et al., 2023). In response to this challenge, a recent strategy within the Rubin framework has emerged: the *Forecasting Approach* for counterfactual construction (Varian, 2014).

Latest literature on counterfactual evaluation has explored various models to estimate the impact of interventions or shocks over time without relying on controls (Botosaru et al., 2024; Brodersen et al., 2015; Cerqua et al., 2023; Menchetti et al., 2023; Papadogeorgou et al., 2023). The main idea of these models is to collect data from the pre-intervention period and use it to predict the hypothetical scenario in the absence of intervention, in order to compare it with the observed one.

To this purpose, we will refer to data on new vehicle purchases in Italy for all the Regions, sourced from the Ministry of Infrastructure and Transport for the years 2010-2019.

4 Research Questions, Main Analysis and Expected Results

Similarly to the evaluation of the Norway feebate scheme (Ciccone, 2018) the research question of this work concern to the impact evaluation of the *feebate* system introduced in March 2019 on different outcomes.

We are interested in the average emissions of newly purchased vehicles expressed in CO_2(g)/km. Additionally, we will assess how the new taxation system affects the number of new vehicles purchased and the vehicle fleet composition: the share of diesel, the share of *polluting* vehicles (<= 70 CO_2(g)/km), the share of *greener* vehicles (> 160 CO_2(g)/km). We expect that the policy has not significant effect on the average emissions of new vehicles sold since a significant share of them typically fall between the two thresholds, as indicated in Table 2. Moreover, we expect a change in the share of green vehicles, with an increase, and of polluting vehicles, with a decrease, although not quantitatively significantly.

We can also suppose that the effect on the total new vehicles sold is not quantitatively significant, as a good share of vehicles falls within the area of where the policy does not intervene, and therefore we do not expect a *Rebound Effect* as happened in France (D'Haultfœuille et al., 2014).

Finally, regarding the assessment of the impact on the proportion of diesel vehicles, we must consider the fact that, if as we expect there has been an increase in green vehicles, then presumably

there has also been an increase in diesel vehicles, as noted in the Norway case (Ciccone, 2018). This can favour the spread of pollutants, such as NO_X and fine dust, and shift the externality from environmental to social, because these harmful pollutants remain at local level affecting people's health (Lelieveld et al., 2015).

Table 2. Share New Vehicles >70;<=160 CO_2(g)/km (2018)

Region	Share	Region	Share
Abruzzo	94%	Molise	92,80%
Basilicata	94,50%	Piemonte	93%
Calabria	96,10%	Puglia	95%
Campania	95,60%	Sardegna	94,9%
Emilia-Romagna	92,60%	Sicilia	96%
Friuli-Venezia Giulia	92%	Toscana	93,9%
Lazio	94,50%	Trentino-Alto Adige	88,8%
Liguria	93,9%	Umbria	94,19%
Lombardia	92%	Valle d'Aosta	91,60%
Marche	94,30%	Veneto	91,81%

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LONG ABSTRACT

Scholarship eligible criteria based on public transport related home –college distance

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Italy's higher education financial aid system primarily includes partial or full tuition fee-waives and scholarships. Eligibility for fee waivers typically depends on students meeting economic and/or academic merit criteria. Scholarships are generally awarded based on a family's financial circumstances and are renewable in subsequent years if students meet specified academic performance standards.

Public funding dominates the financial aid system and the total allocation for university student support has significantly increased in recent years. Despite this, Italy faces critical challenges in higher education participation. Tertiary education entry rates (44%) are the fourth lowest among all OECD countries, and first-time graduation rates (34%) lag behind the OECD average of 49% (OECD, 2019). Additionally, according to the National Agency for the Evaluation of Universities and Research Institutes (ANVUR), only 3 students out of 10 graduate within the standard program duration, and less than 6 in 10 graduate within an additional three years (ANVUR, 2018). These issues – low enrolment, high dropout rates, and extended time-to-degree – underscore systemic challenges in Italy's tertiary education sector. The COVID-19 pandemic has likely exacerbated these issues, though its long-term impacts on student outcomes remain uncertain. To address these challenges, the Italian National Recovery and Resilience Plan (PNRR) includes measures to expand financial aid for university students, such as increasing the availability of scholarships, with the goal of improving access and retention in higher education.

The aim of this paper is twofold. First, it seeks to evaluate how eligibility criteria for scholarships influence inequality in the allocation of financial resources, particularly in cases where small differences in distance to the university result in students falling into different categories. This includes, for instance, students on the borderline between commuter and off-site classifications. Second, the paper aims to analyze the effectiveness of scholarship as a tool for reducing dropout rates and enhancing academic performance. By examining these dual aspects, the study provides insights into the role of scholarships in promoting equity and academic success within higher education.

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Numerous studies have examined the impact of financial aid on university student outcomes. Broadly, the empirical literature indicates that financial aid helps improve equality of opportunities between affluent and low-income students (e.g. Cabrera et al. 1988; Cabrera et al. 1992; Goldrick-Rab, 2006; Goldrick-Rab & Harris, 2009). Alon (2007) highlights that the seemingly negative or negligible effects of financial aid on university persistence – an observation common in studies before the 2000s – are primarily attributable to the endogenous nature of access to such aid. When the non-random selection of aid recipients is not adequately addressed, the effect of financial aid can be misleading, reflecting the characteristics of aid beneficiaries (often low income or minority students) rather than the aid itself. Singell (2004), for example, shows that a $1,000 increase in scholarship funding raises the probability of persisting into the second year of university by 1.4% to 4.3%. Similarly, Arendt (2013) evaluates the impact of a 1988 reform in Denmark, which increased financial aid to $3,000 annually per student. While the reform had minimal effects on dropout rates among students from wealthy, highly educated families, it significantly reduced dropout rates among students from wealthy, highly educated families. In another context, Dynarski (2003), using a difference-in-differences approach, analyses the elimination of a Social Security benefit program for college students. Her findings reveal that grand aid positively influences both college attendance and degree attainment.

The effect of financial aid on time-to-degree completion is more contentious. Glocker (2011) finds no evidence of any impact stemming from a student aid reform in Germany. Conversely, a merit-based scholarship program in West Virginia that required recipients to maintain a minimum GPA and course load significantly reduces the time required to graduate (Scott-Clayton, 2012). Similarly, a Norwegian program that refunded 10% of university loans upon on-time graduation was associated with a measurable decrease in time-to-degree completion (Gunnes et al., 2013).

In summary, the effectiveness of financial aid programs largely depends on their design and the incentives they create. Programs that reduce tuition fees across the board, regardless of student effort, tend to prolong time-to-degree completion. In contrast, those that provide targeted scholarships of fees exemptions based on merit or performance tend to encourage timely graduation.

We utilize individual-level data from the National Register of Students, maintained by the Italian Ministry of University and Research. This dataset, derived from administrative records provided by university registries via a shared information system (ESSE3), offers comprehensive insights into students' academic trajectories.

The National Register of Students includes personal information, such as gender, date of birth, and details about students' high school qualifications, including track, final grade, and graduation date. It also tracks all key academic milestones, including the date of matriculation, enrolled degree program, exit date, and exit reason (e.g. dropout or graduation). Additionally, it records exam data (dates and grades) and financial details, including tuition fees assessed and paid, as well as the type of financial aid received (e.g. partial or full fee waivers, scholarships).

The scholarship is categorized into three distinct types based on the time required to travel from the student's residence to the university using public transport. Students are classified as on-site if they live in the same municipality as the university. Those who reside in a different municipality but can reach the university within 60 minutes by public transport are categorized as commuters. Finally, students are classified off-site if the travel time to the university exceeds 60 minutes by public transport.

We estimate a parametric *fuzzy regression model* exploiting the fact that one of the thresholds that establishes the amount of the scholarship may not perfectly determine the treatment, but it creates a discontinuity in the probability of treatment exposure. By comparing students who meet the two other requirements for receiving scholarships (need and merit based), who are comparable as for the observable characteristics including the family economic condition and who received a scholarship as "on-site", "commuters" or "off-site" mostly based on their travel time, we can disentangle the causal effect of the additional scholarship.

Our findings reveal that economically disadvantaged students who relocate to the university city due to a scholarship face greater challenges in their academic progress compared to peers who remain at home. These students struggle to accumulate the required university credits, which are a prerequisite

for maintaining the scholarship. Furthermore, their academic performance does not compensate for the lower number of credits, as they also achieve lower average grades.

Keywords: Education inequality; Higher education; University subsidies; Academic performance; Fuzzy Regression Discontinuity.

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LONG ABSTRACT

The use of parcel lockers for last-mile deliveries. A systematic literature review

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1 Introduction

The rapid expansion of the e-commerce sector has significantly increased last-mile delivery (LMD) of parcels in urban and suburban areas, fueling the growth of the courier, express, and parcel (CEP) industry. This surge has highlighted the need for innovative technological solutions to enhance last-mile delivery in urban contexts and has driven the adoption of alternative facilities and vehicles. Within the business-to-consumer (B2C) model, home delivery (HD) and delivery to collection points (CPs) or pick-up points are the most common approaches, with parcel lockers (PLs) emerging as a key innovation in the e-commerce market over the past decade (Carotenuto et al., 2022; Lagorio et al., 2020).

Parcel lockers offer couriers an efficient way to save time and fuel by reducing delivery failures or directly routing parcels to lockers. Consumers, on the other hand, often need to travel to pick up deliveries, especially in cases of failed home delivery. PLs, also referred to as CPs, click-and-collect points, mobile depots, or Buy-Online-Pickup-In-Store (BOPS), are typically located near residential areas (e.g., local shops, schools) or in places with high consumer footfall (e.g., gas stations, train stations) (Iwan et al., 2016).

Recent studies on last-mile logistics have extensively examined B2C delivery and pick-up points, focusing on the quality of home delivery services, customer loyalty, and methods for evaluating logistics efficiency. Over the past decade, numerous reviews have explored last-mile delivery solutions, including the optimization of PL locations, design, and features (Lagorio et al., 2020; Rohmer & Gendron, 2020; Yusoff et al., 2023). One key distinction in the literature lies in the technological functionality of PLs compared to CPs. PLs operate as automated systems, accessible 24/7 using technologies such as PIN codes, SMS, or QR codes, with no need for human assistance. Conversely, CPs typically rely on limited operational hours and human reception for deliveries. Studies have also examined consumer acceptance of PLs (Zhou et al., 2020) and evaluated their advantages over alternatives like home delivery, CPs, and even drones. Researchers have analyzed the performance of PLs, including delivery speed, punctuality, safety, and customization options for consumers. The

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placement of PLs in diverse locations, such as supermarkets and other hubs for goods and passengers, has raised questions about consumer acceptance across user demographics and the equitable distribution of these facilities, particularly for underserved or low-income groups.

Despite advancements, significant gaps persist in understanding the full potential of parcel lockers (PLs), particularly their impact on traffic congestion, decarbonization, and delivery efficiency. Behavioural studies have explored PL acceptance using frameworks like the Diffusion of Innovation (DOI) theory (Rogers, 1961), but global diffusion and theoretical analyses remain limited.

This systematic review, spanning 2000 to 2024, follows the PRISMA protocol for transparency and rigor. Using Scopus, Web of Science, and TRID, papers were selected based on predefined criteria, with cross-referencing adding further relevant studies.

The review provides a structured comparison with existing LMD literature, analysing the evolution, advantages, and challenges of PLs. It highlights key factors like success metrics, deployment barriers, and insights from both logistics' operators and consumers. This approach contributes to a deeper understanding of PLs' role in last-mile delivery and their potential to transform logistics processes.

2 Results and implications

This systematic review highlights the multifaceted nature of PLs in LMD, examining their evolution, benefits, challenges, and adoption. The descriptive analysis of the selected articles reveals that the conceptualization and use of PLs have shifted significantly since their early introduction as collection points in the 2000s. Over time, PLs have been defined by their technological features, including fixed or mobile designs, automation (*Automated Parcel Lockers*), and smart capabilities (*Smart Automated Parcel Lockers*). These advancements, while innovative, have brought both opportunities and challenges for LMD. The content analysis clusters the literature into key thematic areas: technology, environmental sustainability, behavioural attitudes, costs, and innovation. While PLs have the potential to optimize delivery times and costs, these benefits often favour companies more than consumers or the environment. Several studies show that consumers perceive PLs as complex compared to traditional HD, with issues related to technology usability, accessibility, and maintenance. The environmental advantages of PLs, such as reduced delivery failures and vehicle emissions, are offset by consumer reliance on cars to access PLs, limiting their contribution to decarbonizing LMD.

2.1 Research Gaps and Directions for Future Research

This review identifies several research gaps that warrant further investigation:

- Environmental Impact: More comprehensive studies are needed to quantify the environmental benefits of PLs, particularly under scenarios where consumer travel to PLs is minimized. Exploring cooperative models among logistics companies to optimize deliveries and reduce emissions could provide actionable insights.
- Consumer Behaviour: Research should focus on understanding consumer preferences, usability issues, and barriers to adoption, particularly among different demographic groups.
- Economic Feasibility: Future research should explore the cost-benefit dynamics of PL implementation for both companies and consumers. This includes examining investment requirements, operational costs, and the long-term economic sustainability of PLs in various market categories.
- Technological Integration: Studies should investigate how technological advancements, such as mobile apps, real-time tracking, and enhanced security measures, can improve the usability and appeal of PLs for consumers while addressing privacy and maintenance concerns.
- Suburban and Rural Adoption: Research should assess how PLs can be tailored to meet the needs of suburban and rural areas, where logistical challenges differ from urban settings. This includes exploring innovative models for decentralized PL networks.

Further complexities arise in delivery management when shifting from urban centres to suburban or peripheral areas, where infrastructure and consumer behaviours differ. Research also highlights a

technological gap in PL adoption, including privacy concerns, lack of consumer awareness, and maintenance challenges. Additionally, PLs are often viewed as equivalent to CPs by both consumers and logistics operators, which raises questions about their distinct value proposition in the logistics ecosystem.

From an economic perspective, the cost of implementing and maintaining PLs remains unclear, particularly for companies operating in developing nations. Theft protection and the high costs of automated equipment pose additional barriers to adoption. Consumer behaviour, a critical factor in the success of PLs, underscores the importance of delivering reliable, fast, and flexible services at minimal cost. However, consumers are generally unwilling to pay for premium logistics services, further complicating the economic feasibility of PL deployment.

Key Words: parcel lockers; last-mile logistics; systematic literature review; innovation diffusion theory.

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LONG ABSTRACT

Trasformare la logistica marittima: distinguere i cambiamenti significativi dalle mode passeggereire

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CIELI (Italian Centre of Excellence on Logistics, Transport, and Infrastructures), Università degli studi di Genova

1 Introduzione

L'industria marittima rappresenta un motore cruciale del commercio globale, responsabile di oltre l'80% delle attività commerciali mondiali (Wang, Cheng, & Zhen, 2023), ed è al centro dell'innovazione tecnologica. Tecnologie emergenti come le navi autonome (Alamoush & Ölcer, 2024), l'Internet delle cose (IoT) (Zhou et al., 2024)e i sistemi basati sull'intelligenza artificiale (Ilias et al., 2023) stanno trasformando le operazioni marittime, contribuendo alla sostenibilità e alla crescita economica. Si prevede che il mercato globale delle tecnologie marittime raggiunga i 266,5 miliardi di dollari entro il 2028 (KBV-Research, 2023), con l'Unione Europea che nel 2023 ha investito oltre 18 milioni di euro in tecnologie digitali per il settore marittimo (Commission, 2024).

Tuttavia, l'entusiasmo per queste nuove tecnologie spesso ne oscura il reale potenziale a lungo termine (Templier & Pare, 2015). Alcune innovazioni possono rispondere a esigenze immediate o essere guidate da tendenze di breve periodo, piuttosto che offrire soluzioni sostenibili. Ciò rappresenta una sfida per gli attori del settore, che, sotto la pressione di mantenere la competitività, possono adottare tecnologie che offrono solo benefici temporanei (Blichfeldt & Faullant, 2021). In un contesto caratterizzato da regolamentazioni ambientali stringenti e da una crescente domanda di pratiche più ecologiche, è fondamentale distinguere quali tecnologie promuoveranno cambiamenti duraturi e quali invece si riveleranno effimere. Questo dilemma è esemplificato dall'adozione limitata dei terminali automatizzati, nonostante l'iniziale entusiasmo.

Questo studio mira a colmare questa lacuna distinguendo tra tendenze tecnologiche autentiche e parole d'ordine transitorie nel settore della logistica marittima. Attraverso una revisione sistematica della letteratura (Systematic Literature Review, SLR) che include letteratura accademica, letteratura grigia e rapporti di settore, la ricerca esplora il significato a lungo termine delle tecnologie emergenti. Metodi come l'analisi delle tendenze, il confronto delle prime apparizioni e l'analisi bibliometrica vengono utilizzati per valutare l'allineamento delle tecnologie con le prospettive sia della ricerca accademica sia dell'industria.

I contributi attesi di questo studio includono la fornitura di un quadro per distinguere tra tendenze durature e parole d'ordine, garantendo un'analisi completa attraverso fonti diversificate e offrendo approfondimenti utili a orientare la ricerca futura e le decisioni politiche. L'abstract esteso è strutturato

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come segue: la Sezione 2 descrive la metodologia, la Sezione 3 presenta i risultati, e la Sezione 4 conclude con osservazioni finali e implicazioni per ricercatori, decisori politici e attori industriali.

2 Approccio Metodologico

Questo studio adotta un approccio metodologico basato sulla Revisione Sistemica della Letteratura (Systematic Literature Review, SLR) per analizzare e distinguere le tendenze consolidate dalle parole d'ordine (buzzwords) nel settore delle tecnologie marittime. La SLR rappresenta un quadro metodologico rigoroso e strutturato che consente di valutare in modo imparziale sia la letteratura scientifica che quella grigia, seguendo criteri di selezione e domande di ricerca ben definiti.

L'approccio metodologico si articola in cinque fasi principali:

1. **Formulazione del problema**: Questa fase si concentra sull'identificazione delle tecnologie marittime con impatti a lungo termine e sulla distinzione rispetto a quelle caratterizzate da effetti temporanei o guidate da tendenze passeggere. Le domande di ricerca mirano a individuare progressi tecnologici significativi, a mappare le parole chiave più ricorrenti nella letteratura marittima e a riconoscere schemi rilevanti che riflettono le dinamiche del settore.
2. **Esplorazione della letteratura**: L'indagine include una ricerca approfondita nella banca dati Scopus, nelle fonti industriali come Tradewinds e nei progetti finanziati dall'Unione Europea attraverso TRIMIS. Questo approccio multi-sorgente garantisce una visione completa che integra prospettive accademiche, industriali e applicazioni pratiche. La ricerca accademica si concentra su articoli pubblicati in riviste sottoposte a peer review, selezionati tramite un filtro basato sulle citazioni, con un intervallo temporale che va dal 1990 al 2024.
3. **Valutazione delle fonti**: La letteratura grigia proveniente da Tradewinds e TRIMIS viene analizzata per identificare tendenze in tempo reale e cambiamenti nel settore, mentre ricerche su Google vengono utilizzate per raccogliere studi di caso e applicazioni pratiche di tecnologie marittime. Tutte le fonti vengono sottoposte a una procedura rigorosa di selezione basata sul protocollo PRISMA (Moher, Liberati, Tetzlaff, Altman, & The, 2009), garantendo qualità, rilevanza e coerenza tematica con i focus principali dello studio: digitalizzazione e decarbonizzazione.
4. **Analisi e clusterizzazione tematica**: L'analisi prevede l'identificazione delle frequenze delle parole chiave e la loro organizzazione in cluster tematici per individuare pattern ricorrenti. Questo processo è supportato da metodi bibliometrici e da una valutazione qualitativa delle fonti.
5. **Validazione**: La selezione e la classificazione dei cluster tematici e delle parole chiave sono ulteriormente validate da un focus group di esperti accademici. Questo passaggio garantisce la robustezza scientifica delle conclusioni e rafforza l'affidabilità delle raccomandazioni derivanti dallo studio.

Grazie a questo approccio metodologico, lo studio fornisce un quadro esaustivo delle dinamiche del settore marittimo, offrendo strumenti utili per distinguere tra innovazioni autentiche e fenomeni temporanei, guidando così decisioni strategiche per investimenti futuri e politiche di sviluppo.

3 Risultati

Questa sezione analizza i dati provenienti da Scopus, Tradewinds, TRIMIS e casi studio reali per distinguere tra tendenze durature e buzzword temporanee nel settore delle tecnologie marittime. L'analisi comprende valutazioni comparative, analisi temporali e tassi di crescita, integrati da un'analisi bibliometrica delle frequenze di citazione e dei cluster di parole chiave. Questo approccio multifattoriale offre una comprensione globale del campo, evidenziando le tendenze sostenibili rispetto ai fenomeni transitori. A causa dei limiti imposti dal formato dell'abstract esteso, viene presentata solo una parte dei risultati.

3.1 Confronto delle Prime Apparizioni

Questa sezione esamina l'attenzione iniziale ricevuta dalle innovazioni marittime attraverso la ricerca accademica, l'industria, i progetti finanziati dall'UE e le applicazioni nel mondo reale, al fine di

identificare le loro traiettorie di adozione. La Figura 1 illustra la prima apparizione di ciascuna parola chiave nei vari dataset, evidenziando le diverse fasi di riconoscimento e adozione. Innovazioni come i carburanti alternativi e l'intelligenza artificiale seguono un percorso "guidato dall'accademia", iniziando con la ricerca e proseguendo verso le applicazioni industriali e l'uso nel mondo reale. La propulsione verde, l'IoT e i porti verdi seguono un approccio "guidato dall'industria", con un iniziale interesse industriale seguito da ricerca accademica e finanziamenti per progetti. Blockchain e Sincrorodalità sono inizialmente trainati da progetti finanziati dall'UE. L'automazione e l'AIS emergono dalle applicazioni nel mondo reale, seguite dall'industria, dai finanziamenti UE e dalla ricerca accademica. Il digital twin ha ricevuto attenzione da tutte le fonti, mentre altre tecnologie mostrano una presenza diffusa, suggerendo tendenze forti. Tuttavia, è necessaria una ulteriore analisi per distinguere tra tendenze genuine e buzzword effimere.

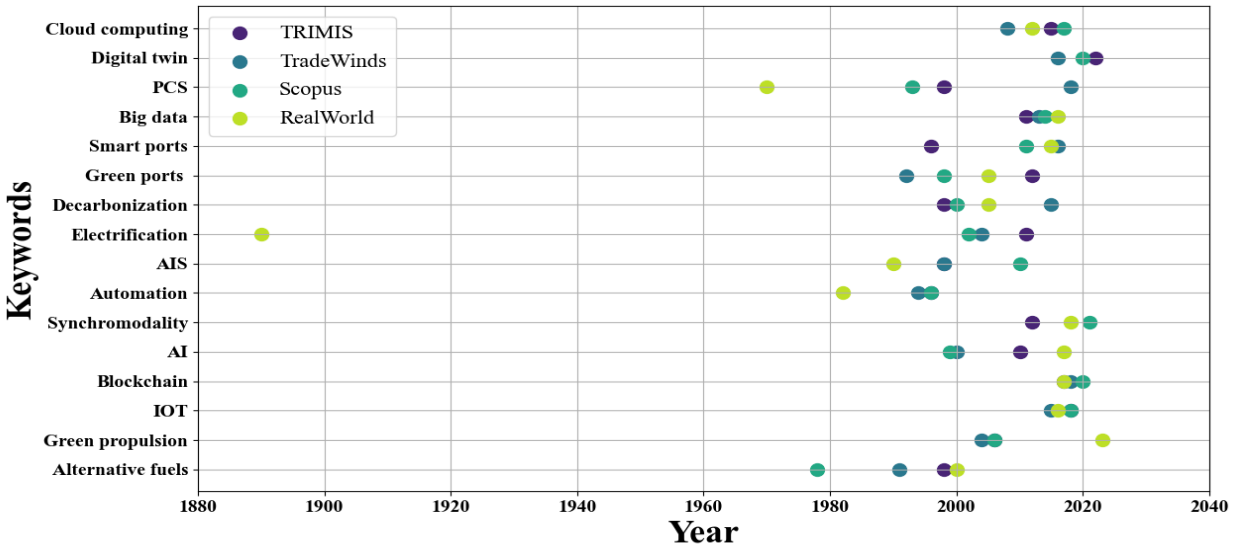

Figura 1: Confronto dell'attenzione iniziale verso le parole chiave da parte del mondo accademico, dell'industria e dei progetti finanziati dall'UE.Analisi delle Tendenze.

3.2 Analisi delle Tendenze

In questa sezione, presentiamo i risultati della nostra analisi delle tendenze, che include l'analisi temporale e il rilevamento dei picchi, al fine di distinguere le tendenze genuine dalle buzzword effimere nelle tecnologie marittime.

Analisi dell'Identificazione delle Tendenze

L'analisi dell'identificazione delle tendenze, basata sulle frequenze documentali degli ultimi 35 anni, come illustrato nella Figura 2, rivela schemi significativi attraverso Scopus, Trimis e Tradewinds. Innovazioni come i carburanti alternativi, l'IA, l'automazione, i porti verdi e la decarbonizzazione sono emerse alla fine degli anni '90, principalmente grazie ai finanziamenti dell'UE, e sono aumentate costantemente nell'ultimo decennio, indicando tendenze autentiche, in particolare nel campo della sostenibilità e dell'avanzamento tecnologico. L'analisi mette in evidenza una divergenza tra gli ambiti accademici e quelli industriali, con la decarbonizzazione e l'elettrificazione più prominenti nelle fonti accademiche, mentre l'IA continua a suscitare forte interesse nell'industria. Alcuni termini, come la Sincronomodality, i PCS e il cloud computing, mostrano una rilevanza limitata e un impatto minore, suggerendo che si tratti più di buzzword. Nel frattempo, tecnologie come i gemelli digitali, i porti verdi e i porti intelligenti sono cresciute nelle fonti accademiche, ma stanno declinando altrove, riflettendo il mutare degli interessi. Nel complesso, i risultati indicano un settore in maturazione, con una crescente enfasi sulla decarbonizzazione e sull'automazione, alimentata dagli obiettivi di sostenibilità globale e dagli sforzi di digitalizzazione dell'industria.

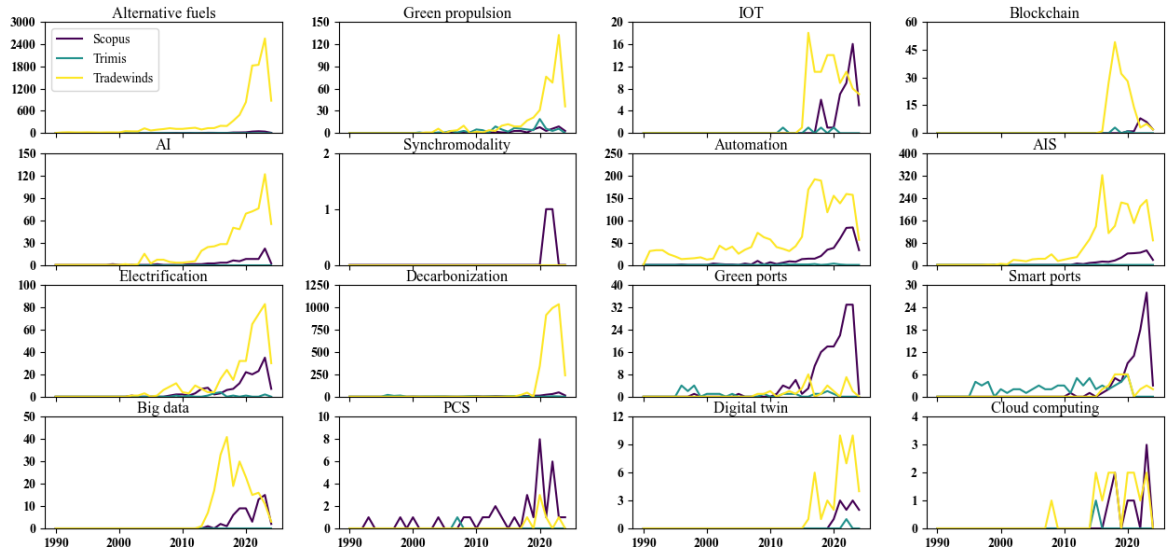

Figura 2: Analisi Temporale della Frequenza dei Documenti: Identificazione delle Tendenze.

Rilevamento dei Picchi

L'analisi del rilevamento dei picchi è stata applicata alle frequenze dei documenti negli ultimi 35 anni su Scopus, Trimis e Tradewinds per identificare i significativi picchi di interesse, come illustrato nella Figura 3. La rappresentazione matematica del rilevamento dei picchi identifica i massimi locali nei dati come i punti $x_i$in cui $y(x_i)$ è maggiore dei valori vicini:

$$\mathrm{P}=\{x_i | y(x_i) > y(x_i - 1) e\, y(x_i) > y(x_i + 1) \quad (1)$$

Questo metodo rivela diversi spunti chiave. I picchi di interesse per i carburanti alternativi e la propulsione verde suggeriscono aumenti intermittenti legati a progressi tecnologici e cambiamenti normativi, mentre i carburanti alternativi mostrano una crescita costante a lungo termine. La propulsione verde mostra picchi stabili, confermando una crescita robusta. Al contrario, l'IoT mostra un interesse variabile, con picchi su Scopus ma meno frequenti su Tradewinds, suggerendo un entusiasmo di mercato fluttuante. Le tendenze di decarbonizzazione mostrano picchi netti su Trimis, alimentati dalle pressioni normative. La blockchain mostra picchi prominenti su Tradewinds, suggerendo un interesse guidato dall'hype, mentre su Scopus si osserva un'adozione più lenta e costante. L'intelligenza artificiale (IA) dimostra picchi forti e sostenuti sia su Scopus che su Tradewinds, evidenziando il suo ruolo trasformativo. Il digital twin e il cloud computing mostrano una crescita minima, indicando un interesse di nicchia.

In conclusione, i carburanti alternativi, la propulsione verde, l'IA, la decarbonizzazione, l'automazione, l'elettrificazione, i porti verdi e l'AIS sono identificati come tendenze genuine grazie alla loro crescita costante su tutte le fonti. I porti intelligenti mostrano una crescita moderata, mentre il digital twin e la synchromodality richiedono ulteriori osservazioni per determinare la loro traiettoria.

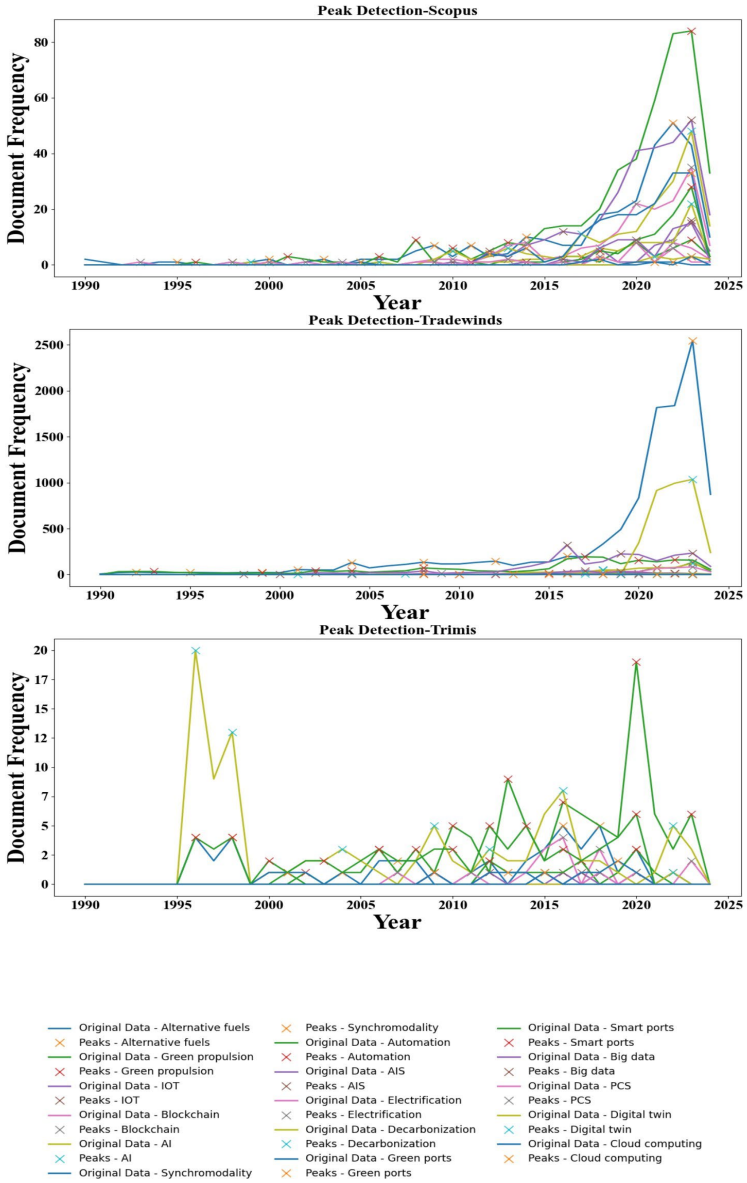

Figura 3: Analisi della Rilevazione dei Picchi nelle Frequenze dei Documenti.

4 Conclusione

In conclusione, questo studio riesce con successo a differenziare tra tendenze genuine e potenziali buzzword nelle tecnologie marittime. Le tendenze robuste identificate includono i carburanti alternativi, l'intelligenza artificiale (AI), la propulsione verde, l'automazione, l'elettrificazione, i porti verdi, il sistema di identificazione automatica (AIS) e la decarbonizzazione, tutte caratterizzate da una crescita costante e da applicazioni nel mondo reale, indicando il loro potenziale impatto a lungo termine sull'industria. Al contrario, tecnologie come IoT, cloud computing, blockchain e PCS mostrano caratteristiche tipiche di buzzword, con un interesse fluttuante e un'adozione limitata, suggerendo incertezze riguardo alla loro rilevanza futura.

I risultati evidenziano l'importanza di distinguere tra queste categorie per orientare decisioni informate per ricercatori, decisori politici e leader industriali. Poiché molte tecnologie emergenti, come la decarbonizzazione e l'automazione, beneficiano già di supporto normativo e politico, è necessario prestare attenzione a tecnologie come IoT e blockchain, che attualmente mancano di quadri normativi adeguati. Ciò richiede uno sforzo più mirato per supportare lo sviluppo e l'adozione di queste tecnologie.

Per garantire investimenti e innovazioni efficaci, è essenziale dare priorità alle tecnologie comprovate e incoraggiare programmi pilota per i concetti emergenti. Il nostro studio sottolinea anche la necessità di future ricerche per colmare le lacune nella disponibilità dei dati e nell'evoluzione delle tecnologie, fornendo una comprensione più completa delle tendenze dell'innovazione marittima. Complessivamente, per promuovere avanzamenti tecnologici sostenibili, sarà necessaria una continua collaborazione, un investimento strategico e un quadro normativo che consenta la trasformazione del settore marittimo.

Parole Chiave: Digitalizzazione; Transizione Energetica; Tecnologia Marittima; Revisione Sistematica della Letteratura; Analisi delle Tendenze

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LONG ABSTRACT

Travel times in Italy

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Travel times are particularly critical in a country like Italy where most trade occurs overland: 87% of domestic trade relies on road freight. Similarly, road transport plays a crucial role within the EU, with 75% of intra-EU trade relying on it. Travel times not only reflect the efficiency of the transport infrastructure but also play a pivotal role in reducing trade costs, which are integral to economic activity, market access, and competitiveness. High transport costs hinder trade by limiting connectivity with distant partners, highlighting the continued importance of efficient and integrated transport infrastructure.

In Italy, the way the transport infrastructure developed has deep historical roots. De Benedictis, Licio, and Pinna (2023) demonstrate that contemporary motorways and railways often trace the routes of the ancient Roman road network. Roman roads were paved, constructed to link strategic points across the Italian peninsula, and designed to connect key locations with straight lines, overcoming geographic obstacles and reducing travel times between centers. This made them natural templates for modern routes.

This paper aims to better understand current travel times in Italy starting from the link existing between the modern and the ancient infrastructure. While distance is the primary determinant of travel times, the quality of the transport infrastructure, the geographical landscape, and the population density are the other factors that make travel times higher or lower. The construction of the modern transport infrastructure in Italy is integrated with all these factors. On the one hand, the existence of Roman roads, which reflect both first- and second-nature geography,[1] determined the placement of early railways in the XIX century and modern roads in the XX century. On the other hand, the distribution of people today is an important feature of the placement of new roads. Additionally, the existence of main and secondary roads, along with railways, within a territory is another element of importance for understanding the role that inter-modality plays on the time of travel. Analyzing how all these factors interact and have an effect on travel times in Italy is an important piece of information for a country that has a challenging geography and deeply rooted historical development.

Travel times reflect accessibility. Accessibility is “the potential for interaction” (Hansen, 1959): it is “the measure of the capacity of a location to be reached from, or to be reached by, different locations” (Rodrigue, 2024). Travel times measure the effort required to reach a location, acting as a surrogate accessibility indicator (Ryan et al., 2024). The literature on accessibility and travel times spans more than 60 years; however, the case of Italy remains largely unexplored. Beria et al. (2017) evaluate Italian accessibility through an exponential decay impedance function that integrates travel times,

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[1] The Roman road network was designed to follow the natural geography of the terrain, overcoming obstacles where necessary to ensure the roads were as straight as possible.

distances, fares, and inter-modality connectivity. Their analysis highlights stark inequalities, with northern regions demonstrating significantly higher accessibility than the southern and remote areas, which remain at a disadvantage. Accordingly, Cascetta et al. (2020) find that high-speed rail significantly enhances accessibility and per capita GDP in the regions it serves, exacerbating regional inequalities and leading to a "two-speed" Italy.

Recently, the availability of new data at both global and Italian levels has renewed interest in the topic of accessibility and travel times. Indeed, subregional-level analyses were relatively rare until recent years. In 2008, the Joint Research Center released the first global map depicting travel times to major cities. This accessibility map, along with corresponding raster data at a 30-arc-second resolution, was developed by Nelson (2008) in collaboration with the World Bank's Development Research Group. The study quantified travel times to cities with populations of at least 50,000 (as of 2000), taking into account geographical barriers, national borders, and the type and quality of transport infrastructure. This work was updated by Weiss et al. (2018), who produced a new map and dataset that calculated travel times to cities for 2015. In 2020, Weiss et al. expanded their work by creating a global map of travel times to healthcare facilities. This map integrates both walking-only and motorized friction surfaces based on 2019 data, accounting for geographical barriers and infrastructural features that either facilitate or impede movement within each pixel. At the Italian level, Istat has released an updated version of the origin-destination matrices for 2020, which include distances in kilometers and travel times in minutes between 7,903 municipalities, using GIS (Geographic Information System) tools and a commercial road network graph.

We take advantage of these data to explore travel times both within and across Italy. We exploit the information at two different territorial levels. On the one hand, the Italian territory is decomposed into small grid cells to explore travel times within territories of 1 km by 1 km, accounting for geography, urbanization, quality of transport infrastructure, inter-modality connectivity, and historical roads. On the other hand, we use municipalities to account for the between connectivity and the link existing between modern and ancient infrastructure: shortest paths in terms of Roman roads and modern transport infrastructure between pairs of Italian administrative centers are used to investigate how much current paths conform to old ones.

Apart from very remote and mountainous areas, the entire Italian territory is crossed by roads or paths that allow the movement of people and goods and connect places. However, not all areas are crossed and connected by the same type of transport infrastructure: having motorways, primary roads, and railways helps in making travel times shorter. However, the presence of tertiary or secondary roads in the neighborhoods offers a viable alternative to alleviate congestion on main roads. The grid analysis uses travel times with the motorized transport infrastructure in 2019 by Weiss et al. (2020) as the dependent variable of a territorial investigation where the units under scrutiny are artificial areas completely detached from administrative and political reasoning. Within these units we account for a set of explanatory variables that allow us to perform a regression analysis that reflects the main dimensions that affect travel times, and to disentangle whether history plays a role on accessibility in Italy through the transport infrastructure. To ensure that our analysis can interface with other studies, we use the cell decomposition provided by Eurostat.

We perform a second regression analysis using Italian municipalities as units of analysis and bilateral travel times from Istat. We rely on the least-cost path analysis and the similarity between the path traced by the ancient Roman roads and the modern path. This analysis allows us to explore a dimension that the within grid analysis does not. We focus on the correspondence between the historical and modern transport infrastructure from an origin to a destination in terms of optimal route that minimizes the cost of moving between two points.

Preliminary results show that modern trajectories that rest more on the historical ones present today lower travel times, distance and geography being equal. Roman roads have demonstrated long-term utility, efficiency, and alignment with geographical and economic demands. This work also confirms one of the main results of De Benedictis et al. (2023): Roman roads serve as a robust instrument in the first stage of an instrumental variable (IV) approach. Their exogeneity and significant influence on the development of modern road networks fulfill the two essential criteria for a valid IV strategy.

Keywords: Travel times; Transport infrastructure; Roman roads; Italy.

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LONG ABSTRACT

The role of the artificial intelligence and smart technologies in the green transition of seaports: the study case of Genoa

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1 Background literature and research contribution

Seaports are increasingly configured as strategic infrastructures affected by profound transformations in response to the new needs of socio-environmental sustainability and adaptation to climate change (Lattarulo and Piccini, 2017), calling for the development of innovative and sustainable solutions in order to play a pivotal role in the promotion of a “blue economy” (WB, 2024; EC, 2024).

In this framework, digitalization, the application of Artificial Intelligence and the development of "smart" and robotic technologies have been identified as tools capable of assisting the sustainable transition of ports and their host cities, in compliance with the logic of the "twin transition" promoted by the European institutions (JRC, 2022).

The concept of “smart ports” has a long history, starting in the 1990s with the emergence of a generation of smart ports that mobilize smart technologies and innovative management practices, as well as initiate collaborations between the private and public sectors (Belmoukari et al., 2023).

Progressively, smart ports evolve in innovative hubs which pursue not only profit-oriented but also community-oriented goals, looking at the use of artificial intelligence and robotic solutions as a key tool to improve the performance of the port and its relationship with the host city in all dimensions of its sustainability.

Sustainable governance of the port city represents a particularly challenging issue for any port area, given the quantity of socio-environmental impacts of port activities and the number and complexity of the stakeholders involved.

A large literature explores the different governance models of port cities, highlighting criticalities especially in small and medium-sized ports (Moretti, 2019; Serry & Loubet, 2019; Sanchez, 2016), due to the difficult management of borders and hinterland, as well as in historical areas, where the mixed urban landscape represents a tricky issue to handle (Moretti et al., 2019; Girard, 2013; Ravetz, 2013).

Although a growing number of studies explore the potential of ICT and IoT in the innovative processes of sustainable management of ports and their host cities (Ettore et al, 2023; Campisi et al 2022), with some recent studies investigating the role of digitalization policies and projects in reducing the environmental and social impacts of small-medium sized Italian ports and improving port-city

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collaboration (Cocuzza et al., 2024; Bonciani, 2022; Vitali and Foschi, 2021), little attention has been devoted to the analysis of the potential of "smart" technological developments in historical seaports.

This study marks a difference with respect to the others as it focuses on one of the most ancient historical seaports in Europe, the port of Genoa, whose local peculiarities (e.g. the coexistence of tourist attractions and the intense traffic of cruise and commercial ships) play a critical role in the environmental governance of the relations between the city and the port.

Our proposal is to analyze a selection of "smart technologies" that are being developed within the EU-funded project RAISE "Robotics and AI for Socio-economic Empowerment"[1] to make Genoa and other Ligurian ports and marinas more sustainable and safer. The research contribution is twofold:

- to provide a classification of the examined technologies, including social robots, smart tools and automated AI-driven devices, based on the analysis of their purposes and key dimensions for the promotion of socio-ecological sustainability and economic relevance;
- to identify the enabling conditions and critical issues for their implementation and scale up by means of a SWOT analysis.

The ultimate goal is to provide some preliminary policy guidance for port authorities and local policy makers engaged in the restructuring and revitalization of old harbors on how to deploy and use smart technologies to promote a "green" city-port governance in support of the development of modern and resilient port cities.

The analyses are based on the material collected through bibliographic research of scientific literature and existing project reports and semi-structured interviews with various project and task leaders; the information collection's methodology and the research questions posed were inspired by the purposes and the typology of the analyses to be performed.

2 Preliminary results

The study focuses on nine technologies within projects 2 and 8 of spoke 4[2] that show the potential for improving the socio-environmental impacts of the port areas and firstly classifies them into three categories based on their "purpose", or the objective pursued: 1) environmental monitoring tools, 2) digital solutions for sustainability, 3) social robots and intelligent devices for livability and safety in port areas. On the top of this taxonomy, the technologies have been analyzed with respect to 5 key dimensions, specifically the 1) socio-ecological impact, 2) the potential economic spillovers, 3) the TRL[3], 4) the replicability and 5) the scalability in other maritime port realities, to provide a synoptic picture of their characteristics.

The peculiarities that emerge from the analysis of the **environmental monitoring** tools are the following: the use or integration of artificial intelligence in the technology, the ability to provide a timely and/or prospective assessment of the environmental situation of the port area in relation to anthropic impacts, an excellent level of technological readiness that predisposes the solutions to replication in other port contexts and to scale-up.

Digital solutions oriented towards **environmental sustainability**, instead, show these prevalent characteristics: the integration of robotic technologies with AI solutions, the common aim of producing more precise and safe environmental observations, estimates and interventions and a good level of starting TRL that creates an excellent basis for replicability and diffusion.

Intelligent devices used to increase **livability and safety in the port area** are characterized in this way: the use of robotic solutions integrated with AI models and advanced AI-based sensors, the aim of improving the livability and safety of those who work for professional reasons, stop for tourist-recreational purposes and/or transit for transport needs, e.g. embarkation/disembarkation (figure 1 shows an experimental test with the social robot "Pepper" at the check-in area of the Genoa Maritime Station) in the port areas taking into account the specific needs (demographic, physical, ergonomic

[1] RAISE is a project funded by the National Recovery and Resilience Plan and it is aimed at creating and strengthening innovation ecosystems in areas of technological specialization consistent with the industrial and research vocations of the Ligurian territory, promoting the collaboration between the research system, the production system and territorial institutions (RAISE, 2024)
[2] RAISE articulates in a governance system made of Hub and Spokes, in which spoke 4 is devoted to the creation of intelligent and sustainable ports through the introduction of robotic technologies (land, air, sea and underwater) and artificial intelligence systems that make the activities carried out in the port area safer, more efficient and sustainable, with regard to both cargo and passenger traffic.
[3] The Technological Readiness Level (TRL) is a methodology for assessing the maturity level of a technology, which is examined with respect to its level of development and implementation and given a score according to the project's progress. Originally introduced by Nasa in 1974, it is now used by numerous research departments and governmental bodies for technological development and regulation, including ESA and the European Commission (EC, 2014).

and disability) of these actors, a moderate initial TRL, since they have been tested in other operational contexts, but the applications are still very experimental in the port arenas.

Figure 1

The results emerging from the exploratory analysis have been used to carry out a SWOT analysis (Benzaghta et al, 2021) aimed at evaluating the potential contribution of each of these technologies to the promotion of a transition path and climate-environmental governance of the port area of Genoa.

The SWOT analysis highlights that, while the examined technologies have a generally advanced maturity (in some cases they are even patented) and are often context-specific and/or multipurpose, characteristics that make them suitable for possible scale-up, they also display some criticalities related to their autonomy, the difficulty of recovering precise data on which to effectively "train" AI algorithms and the complexity of their management that can generate interpretative "biases" of the results produced and the information obtained, undermining the reliability of the tools and hindering their more widespread use. However, if some of these weaknesses have a limited impact on applications in the port area (e.g. autonomy limits), others show margins of improvement thanks to the synergic interaction with complementary technologies.

In terms of exogenous issues, we underscore the susceptibility to everchanging and/or extreme environmental and meteorological conditions and the controversial acceptability and/or poor knowledge of the technology by the stakeholders and users. However, the experimental tests within the project constitute an excellent opportunity to increase or improve the ability of the technologies to integrate new measurement parameters, adapt to their continuous evolution and prove to be useful and reliable "advanced devices" to interact with.

Therefore, in terms of opportunities offered, besides the possible commercial scale-up and implementation beyond the perimeter where the technologies have been preliminarily tested, the study also highlights the possibility of synergistic interaction with other technologies developed both within the project itself and externally to it (e.g. Starlink), the potential in terms of use for environmental "compliance" and "nudging" (Bartmann, 2022) and their safety and support role in accident prevention and assistance to vulnerable subjects in port contexts.

3 Policy implications and conclusion

Three are the main contributions of the technologies analyzed in terms of transition and climate-environmental governance, which can be summarized in the following points: 1) provision of reliable and updated real and forecast environmental data for the continuous and adaptive development and updating of local policies in line with the evolution of port activities and surrounding areas; 2) support for the safety and livability of port work activities and improvement of the port experience for tourism purposes; 3) creation of a technological milieu and best practices essential for the formation of an innovative, intelligent and sustainable city-port ecosystem.

This study also highlights points of contact and synergic interaction between the technologies under development within projects 2 and 8 with those being developed in other RAISE tasks, spokes and "cascade projects"[4], which offers interesting perspective in terms of replication and diffusion in similar contexts.

Further developments of this preliminary study will be devoted to deepening the analysis of the technological enabling conditions, focusing on the resources to mobilize and the stakeholders to involve in order to allow a full integration of these technologies in the port context and their deployment within and beyond the marine areas.

[4] RAISE "cascade projects" represent a follow up of the current RAISE projects aimed at extending the development of smart technologies for ports and marinas beyond the perimeter of the Liguria region, promoting opportunities and leveraging the know-how in the Southern Italy.

Keywords: seaports, smart ports, AI, robotics, sustainable development, twin transition, environmental governance

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LONG ABSTRACT

La città dei 15 minuti: evidenze e domande aperte

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1 INTRODUZIONE

Assistiamo a una crescente preoccupazione per gli impatti negativi dei cambiamenti climatici che si stanno accentuando in tutto il pianeta (Faghri, 2023). L'ultimo rapporto IPCC attribuisce il 70% delle emissioni globali di carbonio alle aree urbane, che devono affrontare ulteriori sfide come l'inquinamento atmosferico, l'espansione urbana e il consumo energetico elevato (Luqman et al., 2023). Inoltre, il 25% delle emissioni energetiche di CO_2 è attribuito ai trasporti, mentre il 78% delle emissioni del trasporto urbano è attribuito alle emissioni veicolari (Allam et al., 2022a). Il concetto di città dei 15 minuti, proposto da Carlos Moreno (2016), prevede la creazione di un modello urbano compatto e connesso, in cui tutti i servizi essenziali sono raggiungibili in 15 minuti a piedi o in bicicletta. L'obiettivo è quello di ottenere aree urbane più vivibili e sostenibili, che non dipendano dall'uso dei mezzi motorizzati privati, in modo da ridurre le emissioni legate agli spostamenti, la congestione del traffico da migliorare la qualità della vita degli abitanti (Allam et al., 2022b). L'obiettivo del presente lavoro è valutare l'efficacia del concetto di città dei 15 minuti nel rendere più sostenibili, eque e resilienti le aree urbane, favorendo l'inclusione sociale a tutela anche dei segmenti più vulnerabili della popolazione (anziani, bambini, meno abbienti). L'analisi esplora anche il ruolo le infrastrutture di trasporto e delle politiche necessarie per implementare il concetto della città die 15 minuti e le dinamiche che influenzano la sua attuazione in diversi contesti urbani.

2 METODOLOGIA

La ricerca ha preso in considerazione gli studi condotti sul tema negli ultimi 10 anni. I documenti utilizzati comprendevano articoli di riviste scientifiche, estratti da volumi e altro materiale ritenuto rilevante ai fini della disamina. La strategia di ricerca dei documenti ha incluso la consultazione delle principali banche dati scientifiche: Scopus, WoS e Science Direct, utilizzando parole chiave attinenti l'oggetto di studio. Sono stati inclusi nella ricerca solo documenti scritti in inglese. Dopo la revisione degli articoli secondo il protocollo PRISMA, sono stati selezionati 55 articoli.

3 RISULTATI E DISCUSSIONE

L'attuazione del concetto di città dei 15 minuti ha mostrato benefici ambientali, come la riduzione delle emissioni di gas serra ed il miglioramento della qualità dell'aria, ottenuti grazie alla riduzione dell'uso dell'auto privata ed all'incremento dell'uso della bicicletta, degli spostamenti a piedi e del

trasporto pubblico. Ad esempio, a Barcellona le emissioni di CO_2 sono diminuite del 25% nel primo anno dopo l'implementazione (Allam et al., 2022a; Moreno et al., 2021).

L'implementazione del paradigma della città dei 15 minuti ha permesso anche di migliorare la qualità dell'aria, riducendo le emissioni di biossido di azoto (NO_2) e di particolato. Ad esempio, il modello Superblock di Barcellona ha ridotto i livelli di NO_2 del 24%, evitando circa 700 morti all'anno (Mueller et al., 2020). Il potenziamento delle infrastrutture ciclabili in applicazione del paradigma della città dei 15 minuti a Copenaghen e Bogotà ridotto gli spostamenti in auto migliorando significativamente la qualità dell'aria e dimostrando il potenziale dei benefici ambientali e di salute pubblica del modello (Freudendal-Pedersen et al., 2023; Keim & Cermy, 2021).

Inoltre, il concetto di città dei 15 minuti affronta il tema della dispersione urbana promuovendo densità urbane più elevate e uno sviluppo misto dell'uso del suolo, assicurando che i servizi che rispondono ai bisogni quotidiani dei residenti siano raggiungibili in 15 minuti a piedi o in bicicletta. Ad Oslo l'aumento della densità urbana e la creazione di centri di servizio multicentrici e di quartiere hanno ridotto i chilometri percorsi dai veicoli del 10-15%. Salonicco ha registrato una riduzione del 30-40% dei chilometri percorsi dai veicoli grazie alla pianificazione di prossimità e alla promozione della mobilità attiva, frenando così l'espansione urbana e riducendo le emissioni dei trasporti (Papadopoulos et al., 2023).

L'inclusione sociale è un altro beneficio fondamentale del modello della città dei 15 minuti che si pone come obiettivo di garantire un accesso equo ai servizi, agli spazi pubblici e alle opportunità economiche a tutti i segmenti della popolazione. Il modello è particolarmente vantaggioso per i gruppi vulnerabili come gli anziani, i bambini e i disabili, migliorando l'accesso ai servizi essenziali e promuovendo la coesione sociale (Ramírez Saiz et al., 2022). Ad esempio, a Lisbona, la costruzione di un'infrastruttura ciclabile protetta ha migliorato l'accessibilità ai servizi per gli anziani (Cunha & Silva, 2023). Il "bilancio dei cittadini" di Parigi, che assegna i fondi pubblici in base ai contributi dei residenti, ha migliorato l'accesso ai servizi e ha impedito la gentrificazione, assicurando che comunità diverse beneficino dei miglioramenti urbani (Freudendal-Pedersen et al., 2023). Tuttavia, fenomeni come l'aumento del 15% dei prezzi degli immobili nelle aree centrali di Barcellona verificatosi in seguito ai miglioramenti urbani garantiti dall'applicazione del paradigma della città dei 15 minuti, evidenziano il rischio di marginalizzare i segmenti economicamente più vulnerabili della popolazione e la necessità di prevenire opportunamente i fenomeno della gentrificazione (Papadopoulos et al., 2023; Pinto & Akhavan, 2021).

Le politiche di trasporto che favoriscono la mobilità attiva, il trasporto pubblico e le soluzioni di mobilità condivisa, sono parte integrante del concetto di città di 15 minuti. Città come Berlino e New York hanno registrato un aumento significativo dell'uso della bicicletta grazie all'introduzione di piste ciclabili dedicate. Berlino ha registrato un aumento del 67% e New York un aumento del 150% nell'uso della bicicletta durante i primi mesi della pandemia COVID-19 in cui le amministrazioni locali si sono attivate per limitare entro i confini di quartiere gli spostamenti della popolazione (Moreno et al., 2021). Parigi ha ottenuto una riduzione del 30% dell'uso dell'auto grazie all'espansione delle piste ciclabili e al successo del programma di bike-sharing Vélib, mentre Vienna ha registrato una riduzione del 10% dell'uso dell'auto grazie ai servizi di mobilità condivisa, tra cui il bike-sharing e gli e-scooter (Freudendal-Pedersen et al., 2023; Radics et al., 2020).

L'attuazione della città di 15 minuti richiede però di considerare opportunamente le specificità locali in termini di capacità economica, fattori geografici e climatici, densità della popolazione e modalità attraverso le quali sviluppare una pianificazione partecipativa ed efficace. Le città con maggiori risorse economiche, come Parigi, hanno implementato con successo il modello, mentre città con minori fondi destinabili alla riqualificazione urbana e con un layout disordinato e meno lineare devono affrontare maggiori sfide (Tarwani, 2020). Il concetto deve essere adattato ai contesti climatici e morfologici locali per garantire l'ottenimento dei benefici attesi (Allam et al., 2022b; Allam, et al., 2022c; Kakderi et al., 2021). Inoltre, la pianificazione partecipata e il coinvolgimento del pubblico sono fondamentali per superare le resistenze e garantire il successo del modello in ambienti urbani anche culturalmente differenti (Lu & Diab, 2023).

4 CONCLUSIONI

Sulla base della letteratura studiata possiamo concludere che il concetto di città dei 15 minuti mostra un potenziale significativo nel migliorare la sostenibilità urbana, ridurre la dipendenza dall'auto e promuovere l'inclusività attraverso modalità di trasporto alternative più ecologiche. Se però è vero che città come Parigi, Portland e Melbourne sono all'avanguardia nell'implementazione del paradigma, molte altre realtà urbane rimangono nelle fasi iniziali di sviluppo del modello, evidenziando la necessità di strategie di adozione più ampie, maggiormente condivise, opportunamente finanziate e pianificate.

La ricerca futura dovrebbe concentrarsi maggiormente sulla valutazione del miglioramento della sostenibilità ambientale garantita nel lungo termine dal paradigma della città dei 15 minuti, sulle misure necessarie per mitigare i rischi di gentrificazione, sulla valutazione delle nuove tecnologie disponibili per gli spostamenti privati in modalità condivisa (veicoli elettrici a guida autonoma) e per la logistica urbana (droni) e sulle modalità di applicazione e sviluppo del paradigma in ambienti urbani con limitate risorse economiche destinabili alla sua implmentazione. Gli osservatori urbani ed i living labs saranno fondamentali per monitorare gli impatti, garantire che i benefici siano equamente distribuiti fra la popolazione ed allineati agli Obiettivi di Sviluppo Sostenibile, e per adattare le strategie alle dinamiche urbane in evoluzione.

Key Words: città dei 15 minuti; mobilità sostenibile; sostenibilità ambientale; inclusione sociale

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LONG ABSTRACT

Un tool user-friendly per stimare l'impronta di carbonio individuale e aumentare la consapevolezza sugli impatti ambientali delle attività umane quotidiane

Antonella Senese[1], Anna Claudia Caspani[2,*], Lorenzo Lombardo[1], Veronica Manara[1], Guglielmina Adele Diolaiuti[1] e Maurizio Maugeri[1]

Negli ultimi decenni, visti gli impatti sempre più evidenti dei cambiamenti, climatici si sta rendendo sempre più importante e urgente aumentare l'attenzione e la sensibilità su queste tematiche ambientali. Secondo Pandey [Pandey et al., 2011], l'impronta di carbonio può essere definita come la quantità di gas serra espressa in termini di CO_2 equivalente ($CO_{2\text{-eq}}$) che viene emessa direttamente e indirettamente nell'atmosfera da un individuo, organizzazione, azienda, processo, prodotto (inclusi beni e servizi) o evento entro un determinato perimetro. Molte aziende, organizzazioni e città stanno sviluppando progetti legati all'impronta di carbonio per stimare il loro contributo al cambiamento climatico globale [Matthews et al., 2008]. Questi contributi devono essere valutati seguendo alcune delle principali metodologie riconosciute a livello internazionale.

Basandosi su una partnership ventennale tra il *World Resources Institute* (WRI) e il *World Business Council for Sustainable Development* (WBCSD), il *Greenhouse Gas Protocol* [GHG, 2023] collabora con governi, associazioni di settore, ONG, aziende e altre organizzazioni [Daviet and Ranganathan, 2005]. Questa organizzazione stabilisce quadri standardizzati globali e completi per misurare e gestire le emissioni di gas serra derivanti dalle operazioni del settore privato e pubblico, dalle catene del valore e dalle azioni di mitigazione.

Oltre a fornire linee guida che indicano alle organizzazioni i protocolli su come monitorare, ridurre e compensare le loro emissioni, il *Greenhouse Gas Protocol* offre strumenti specializzati per calcolare l'impronta di carbonio specifica di prodotti e servizi. Oltre a questi standard, esiste anche quello europeo denominato *Publicly Available Specification* (PAS) 2050:2011, che spiega come calcolare l'impronta di carbonio dei prodotti, identificare le aree critiche e ridurre le emissioni nella catena di fornitura [Boakye et al., 2023]. Il PAS 2050 specifica i requisiti per la valutazione delle emissioni di gas serra lungo il ciclo di vita di beni e servizi, basandosi su tecniche e principi chiave di analisi del ciclo di vita. Inoltre, l'*International Standards Organization* ha sviluppato uno standard per l'impronta di carbonio dei prodotti (i.e. ISO 14067:2018).

I consumatori hanno il potere di influenzare l'impronta di carbonio di beni e servizi attraverso le loro decisioni di acquisto, e per poterla ridurre devono essere adeguatamente informati. Per rispondere a questa esigenza, è necessario sviluppare strategie per sensibilizzare le persone su quali attività abbiano un maggiore impatto ambientale nella loro vita quotidiana. Con questo obiettivo, abbiamo formulato due strumenti per quantificare l'impronta di carbonio individuale su base annua.

Grazie ad un progetto partito nel 2018, in collaborazione all'inizio con Vaillant Italia Spa, abbiamo sviluppato un'applicazione web (tramite il software Zoho Forms, disponibile al link https://forms.zohopublic.eu/lorenzolombardo/form/Improntacarbonica/formperma/s4E2iJ7IpH4zGpC8b63hIbIIN2H_bvgvWiiYrKQBZRA) per stimare l'impronta di carbonio individuale. L'innovazione di questo *tool* risiede nella sua facilità di utilizzo, nell'accessibilità online gratuita e nell'utilizzo di fattori di emissione specifici per il contesto di riferimento. Anche se implementato con

fattori di emissione italiani, un'altra caratteristica importante di questo strumento è che può essere modificato da amministratori con competenze informatiche limitate. Questa funzionalità permette di aggiornare continuamente i fattori di emissione in caso di cambiamenti rilevanti. La versatilità e facilità di utilizzo rende questa web app facilmente utilizzabile anche in attività didattiche e tirocini per studenti di scienze ambientali, e non solo, interessati al calcolo delle emissioni di carbonio. Sebbene focalizzato sulla situazione italiana, lo strumento è stato reso disponibile anche in lingua inglese per soddisfare le esigenze di una rilevante quota di studenti internazionali presenti in Italia. Inoltre, potendo sostituire agevolmente i fattori di emissione italiani con quelli di un altro paese, la versione in lingua inglese della nostra web app risulta adattabile ed esportabile per qualsiasi altro contesto.

Per la stima dell'impronta annuale di carbonio individuale, ci siamo concentrati sulle principali fonti di emissione: consumo di gas ed elettricità, mobilità, alimentazione e gestione dei rifiuti. Negli ultimi anni, questo tool è stato proposto a studenti italiani di diversi livelli scolastici e a dipendenti di aziende italiane e internazionali.

Le risposte di 3260 utenti hanno rivelato un'impronta di carbonio diretta media annua pro capite di circa 5600 kg di $CO_{2\text{-eq}}$. Integrando questo dato con una stima delle emissioni indirette, si ottiene un valore in buon accordo con quello fornito dall'Inventario Nazionale Italiano dei gas serra. Grazie a questo tipo di strumento, le persone possono osservare in quali settori del loro stile di vita hanno il maggiore impatto e, di conseguenza, sono stimolate a ridurre le emissioni adottando comportamenti più sostenibili.

Dall'analisi dei risultati relativi alla mobilità, è emerso che l'automobile è il mezzo di trasporto più utilizzato. In generale, nelle statistiche europee, l'Italia si colloca tra i paesi che fanno il maggior uso dell'auto per gli spostamenti. I risultati relativi al tipo di carburante per auto rispecchiano la composizione del parco veicoli italiano: nel 2019, le auto in circolazione in Italia erano per il 46% a benzina, 44% a diesel, 2,4% a metano e 6,5% a GPL. I valori ottenuti sono in linea con le medie riportate da ISPRA (2021), confermando l'efficacia del nostro metodo nello stimare l'impronta di carbonio individuale attraverso poche domande semplici sullo stile di vita.

L'esperienza acquisita durante l'analisi dei dati della *web application* ha permesso di individuare alcune possibilità di sviluppo, sia nel metodo di raccolta dati sia nella strategia di comunicazione, per ottimizzare e rendere più accurata la metodologia di stima. Per aumentare l'affidabilità dei risultati, in particolare per quanto riguarda l'impatto del riscaldamento e dell'elettricità, si potrebbe implementare la web app consentendo agli utenti di inserire i dati delle bollette. Le informazioni precise fornite dalle bollette ridurrebbero gli errori di stima e permetterebbero un confronto più accurato della variabilità a livello di area geografica grazie alla disponibilità di dati primari.

L'opinione del compilatore potrebbe essere il punto di partenza più importante per individuare miglioramenti a livello comunicativo. La possibilità di lasciare un commento aperto per esprimere un'opinione sulla struttura del tool consentirebbe di intervenire sull'efficienza dello strumento e di prevenire l'abbandono durante la compilazione.

In conclusione, la nostra *open-access* web app per la stima dell'impronta di carbonio è risultato essere uno strumento efficacie, intuitivo e utile per quantificare le emissioni individuali di $CO_{2\text{-eq}}$. Può inoltre essere considerato anche un valido strumento per l'educazione scientifica ambientale, con possibilità di collegamento a discipline come scienze della terra, fisica, chimica, informatica e matematica.

Parole chiave: *online tool*; emissioni di gas serra; impronta di carbonio; impatto individuale; consapevolezza ambientale.

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LONG ABSTRACT

Assessing inequality in access to healthcare services in Milan

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Population well-being is a multidimensional concept whose inequality manifestations depend on both monetary and non-monetary variables (Sen, 1992; Bourguignon & Chakravarty, 2003). Whereas a higher income would allow a person to improve the position of her/his own monetary and non-monetary assets, income should be combined with other attributes, i.e., housing, life expectancy, public goods provision, etc. From a measurement perspective, as stressed in Su et al. (2024), inequality is detectable not only across spatial scales, e.g., from small communities to regions, but also across social and economic characteristics (Therborn, 2014) encompassing the asymmetrical distribution of income, educational opportunities, and well-being dimensions (see Xu et al., 2022).

As a such, the provision of services to preserve physical and mental well-being represents a key source of inequality (see, among others, Kolm, 1977; Atkinson & Bourguignon, 1982; Maasoumi, 1986; Tsui, 2002) as healthcare often provides inadequate services in terms of quantity and/or accessibility, especially in low-density urban areas characterized by a limited demand from different social groups and/or less interconnected zones (Smith, 2002; Myambo, 2018; Clark et al., 2022). Spatial inequality and socio-spatial divide has indeed exacerbated social disparities within cities and distorted urban opportunities, with a critical emphasis on healthcare (Fayet et al., 2020; UN, 2020). Among essential social services in citizens' lives, in fact healthcare services play a crucial role, particularly evident in the vulnerability of hospital and medical systems during the Covid-19 pandemic (Bi et al., 2022; Su et al., 2024). Given this general overview on the importance of healthcare services and their relevance in urban contexts, in this paper we aim to contribute to the literature on spatial inequality and accessibility in healthcare, with a particular focus on the city of Milan.

We explore inequality in access to healthcare services in Milan using data from the municipality's open data portal. Healthcare facilities are spatially identified by their civic address. Each civic address is geocoded by its UTM coordinates using JAVA script to retrieve information from Google Maps geographical databases. The resulting dataset enables a detailed and visually comprehensive geographic analysis of healthcare accessibility, measured by travel distance using driving as the mode

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of transport. Figure 1 shows healthcare accessibility within the city of Milan. Dark yellow indicates higher accessibility, while the absence of color represents a lack of healthcare services. It is evident that the city of Milan has satisfactory healthcare service coverage – , which is particularly dense in the dark yellow areas – but absent in certain peripheral zones, especially those located in the western part of the city.

Inequality in access to healthcare services is measured by a Gini index, which is calculated at 0.15. This value is markedly lower than the Gini index calculated by D'Ovidio (2009) for the early 2000s, approximately 20 years prior to this analysis. D'Ovidio study reported an income Gini index of 0.51, highlighting a substantial disparity in income distribution during that period compared to the more equitable distribution observed in healthcare accessibility. However, our findings suggest that, although access to healthcare services is distributed more equitably than income, there remains a pressing need to enhance accessibility in certain peripheral areas of the city. These areas grapple with social marginalization and are marked by relatively high percentages of low-income households, including single-parent families and foreign-born residents who frequently face precarious employment conditions.

Figure 1. Accessibility to healthcare facilities in Milan.

Keywords: Accessibility; Health inequality; Gini index; Milan.

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