

# BIKE SHARING IS A LIVING CREATURE

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WHY PISA'S BIKE SHARING SYSTEM HAS NO THEFT AND NO VANDALISM

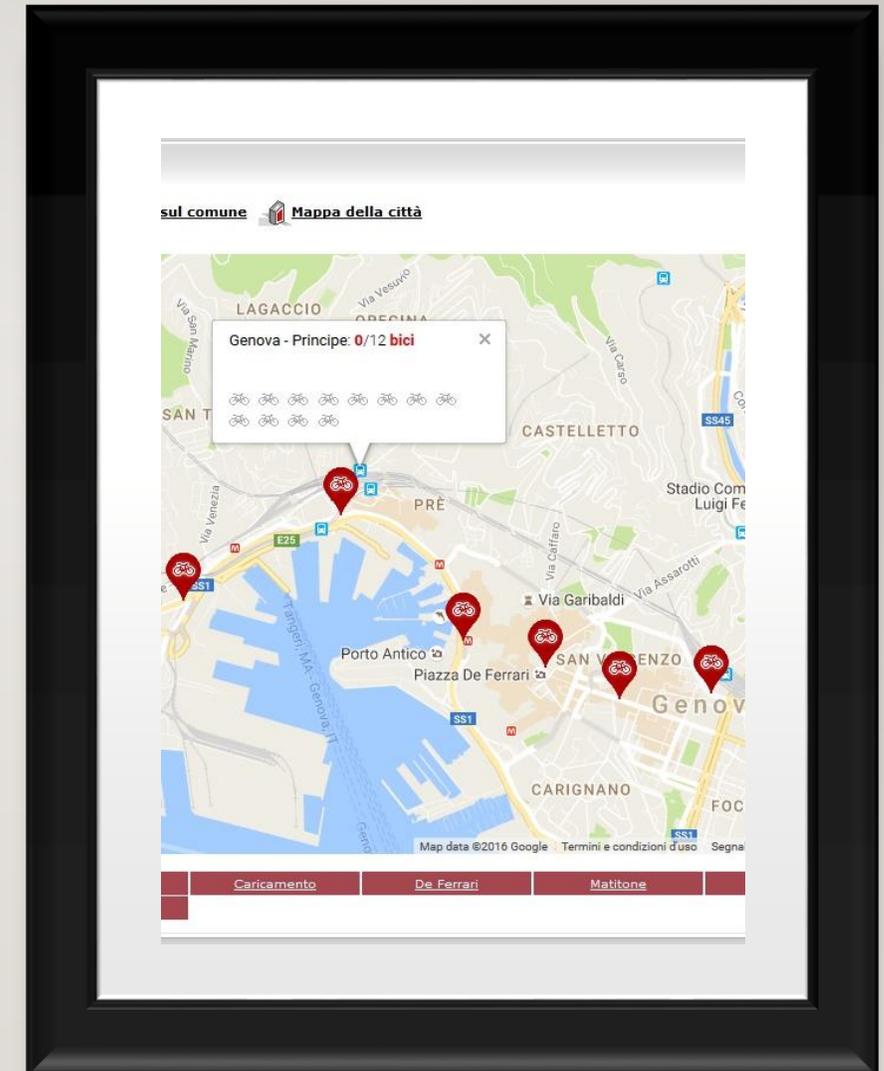
*MARCO BERTINI - PISAMO - PISA BIKE OFFICE*



# CITY OF PISA BEGUN TO WORK ON BIKE-SHARING PROJECT IN 2008. IN THAT TIME WE HAD A LITTLE BUDGET TO WORK ON.

Thanks God we decided to wait for a better period when we could design the new service with a big-enough amount of money

In Italy we know a lot of cities that "started" the service with poor energy and budget (just for have the BS-medal?) and the few stations were vandalised very soon.



**IN 2011** FINALLY THE CITY COUNCIL PUT IN **BUDGET PLAN** THE REQUESTED AMOUNT FOR A BIG-ENOUGH SYSTEM. SO **STRONG WAS THE FEELING THAT THE ROBBER WOULD WORK HARD ON OUR BIKES**, THAT WE REQUIRED 20 NEW BIKES EACH YEAR TO REPLACE THE VANISHED ONES.

In the meanwhile we started a collaboration with the best scientific labs to approach the problem with due knowledge. A **big survey** about bike sharing was made, obtaining **6'000 responses** and precious data.



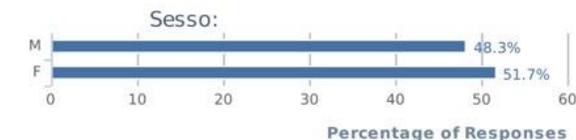
## Analisi dei risultati

*Andiamo ora ad analizzare nel dettaglio le domande del questionario e le relative risposte fornite.*

### Dati anagrafici degli intervistati:

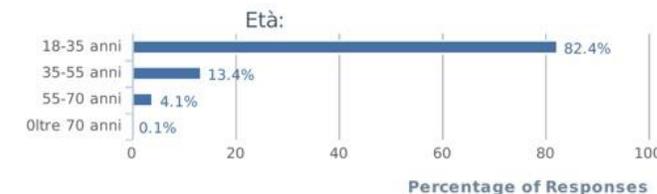
Sesso:

	Count
M	<b>3065</b> (48.3%)
F	<b>3276</b> (51.7%)
<b>Responses to this question</b>	<b>6341</b>



Età:

	Count
18-35 anni	<b>5226</b> (82.4%)
35-55 anni	<b>850</b> (13.4%)
55-70 anni	<b>260</b> (4.1%)
Oltre 70 anni	<b>5</b> (0.1%)
<b>Responses to this question</b>	<b>6341</b>

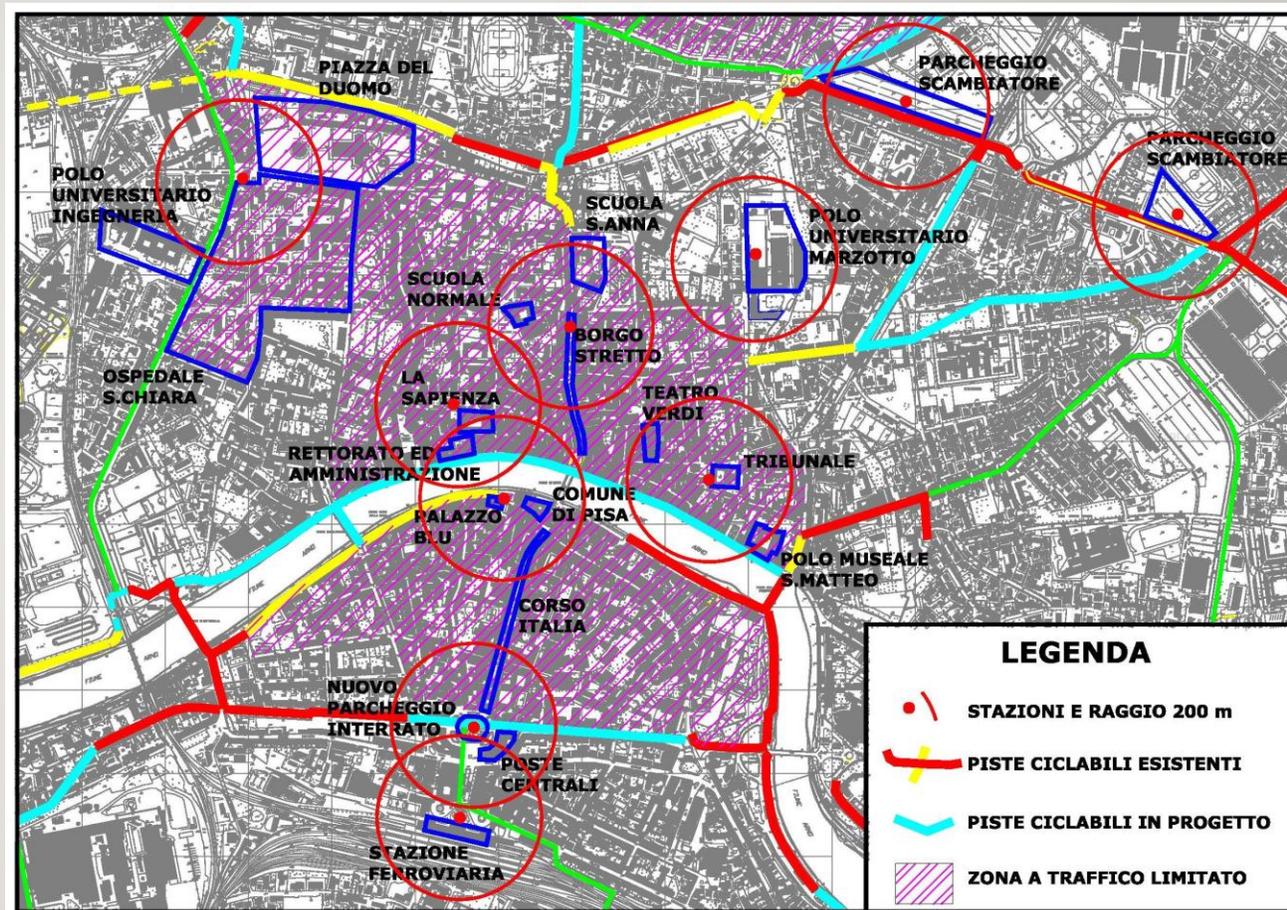


# WE CHOOSE THE PLACES FOR OUR STATIONS THINKING AT THE VISIBILITY AND USAGE OF THE SITE. POINTS OF INTEREST – MODAL EXCHANGE PARKINGS

The more are **the stakeholders working on the project**, the best will the service work. We had a strong cooperation **with Pisa University and CNR** (national research council).

**H-24 opening** hours for the service, is the best way to survey against the thieves.

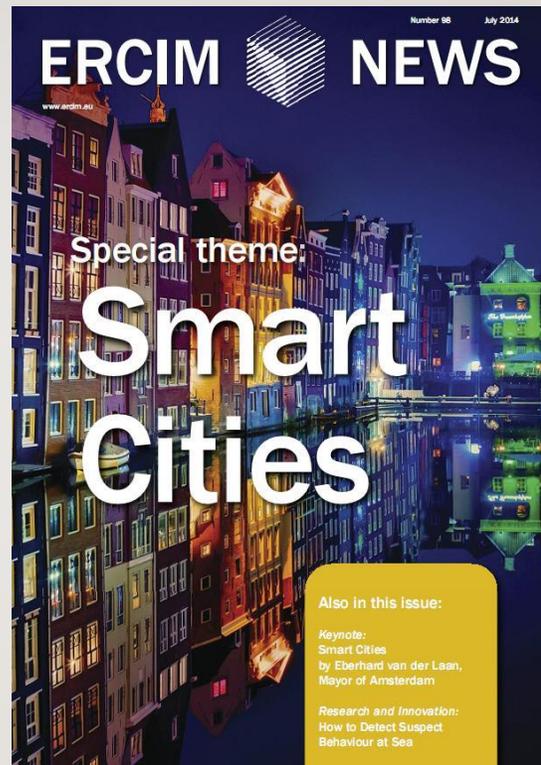
**Students** (as blood in BS's veins) are a big part of the energy bike-sharing requires.



# EVERY LOCAL BUSINESS ASK FOR NEW STATIONS (I.E. IKEA IS BUYING IT'S OWN STATION).

CNR published a study on our BS system on an **international review** (ERCIM) based on an EU-funded project (QUANTICOL)

**Tuscany government** is giving us more funds to grow more.



Special Theme: Smart Cities

## A Quantitative Approach to the Design and Analysis of Collective Adaptive Systems for Smart Cities

by Maurice van Beek, Luca Borriani, Vincenzo Ciancio, Stefania Gnani, Jane Hillston, Diego Latella and Mieke Massink

It's smart to be fair: Researchers from the Formal Methods and Tools group of ISTI-CNR are working on scalable analysis techniques to support smart applications for the efficient and equitable sharing of resources in the cities of our future. The research is being carried out under the European FP7-Proactive project, QUANTICOL.

The Smart City concept is on the research agenda of many European Union (EU) and other international institutions and think-tanks. As urban populations grow, innovative information and communication technology (ICT) initiatives are seen by many as one of the key factors that will allow modern cities to reach or maintain a good and sustainable quality of life for their inhabitants, allowing for the timely and equitable distribution of resources.

These ICT-based systems are based on decentralised and distributed designs, composed of many autonomous and interacting entities, known as collective adaptive systems (CAS). CAS are required to adapt their services dynamically to the changing needs of their users, who also form an integral part of the system. They typically consist of a large number of spatially distributed, heterogeneous entities with decentralised control and varying degrees of complex autonomous behaviour. This requires the development of novel scalable analysis techniques to investigate their dynamic behaviour and support the design and operational management of a wide range of such systems.

In the QUANTICOL project [1], three principal case studies drive the development of a design and analysis framework for CAS: two smart urban transportation systems (smart bus systems and bike-sharing schemes) and smart grid applications.

In the first year of the project, we developed several scalable analysis techniques that exploit mean field and fluid flow techniques, in combination with logic-based model-checking, to support the investigation and prediction of dynamic resource usage. Mean field techniques were originally developed in the field of statistical physics to cope with the analysis of very large scale systems composed of interacting objects such as molecules in a gas. The possibly non-linear behaviour of such systems is conveniently modelled by a deterministic approximation, i.e., the limit for an infinite number of agents, given as the solution of a set of differential equations (in the continuous case) or difference equations (in the discrete case). Their combined application with model-checking techniques provides a way to verify properties of individual entities in the context of a large system on which they depend, but also properties of the global system or combined local and global properties. An example is the study of the potential effects of user-incentives on maintaining a satisfactory distribution of bikes and empty parking slots over time. The extension of these techniques to address spatial aspects, including spatial model-checking, is a major objective of the project [2].

A further objective of QUANTICOL is to study the relationships between (representations of) small populations and a compact (family) representation of a large population 'built' from these smaller populations, by indicating the commonalities and variabilities of single entities in their overall environment. As an initial step in this direction, we performed variability analyses on a bike-sharing product line, considering its behaviour to exhibit variability, not only in the kind of features involved but also in the timing and probability characteristics of these features.

In this context, ISTI-CNR initiated a collaboration with 'Pisamo S.p.A. azienda per la mobilità pisana', an in-house public mobility company in the Municipality of Pisa, that had recently introduced a public bike-sharing system (CicliPi) in Pisa. This led to an initial feature model of a family of bike-sharing systems, annotated with attributes and global quantitative constraints aiming to minimize the total cost of a chosen configuration while simultaneously aiming to maximize customer satisfaction and capacity (of docking stations).

We have studied the specification and analysis of the possible behaviour of a family of bike-sharing systems in terms of the capacity of their docking stations in a value-passing modal process algebra, considering a dynamic redistribution scheme as an optional feature. Future work includes studying a further parametric extension of the value-passing modeling and verification environment as well as the addition of a quantitative dimension to the behavioural model.

QUANTICOL will run until March 2017 and is coordinated by Jane Hillston from the University of Edinburgh (UK). Other partners are EPFL (Switzerland), IMT Lucca (Italy), University of Southampton (UK), LMU (Germany), INRIA (France) and ISTI-CNR (Italy). We thank Marco Bernini from Pisamo S.p.A. for generously sharing his knowledge on bike-sharing systems with us.

Links:  
 QUANTICOL: <http://www.quanticol.eu/>  
 Pisamo: <http://www.pisamo.it>

References:  
 [1] L. Borriani et al.: "A Quantitative Approach to the Design and Analysis of Collective Adaptive Systems, F/CAS'13, Taormina, Sicily, Italy, 2013.  
 [2] J. Hillston: "Challenges for Quantitative Analysis of Collective Adaptive Systems", TGC 2013, Buenos Aires, 2013, Springer LNCS, Vol. 8358, pp 1421, 2014. DOI: 10.1007/978-3-319-05116-2\_11

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Figure 1: public bike-sharing system (CicliPi) in Pisa



IF A CITY COUNCIL, AND TECHNICAL BOARD OPERATING FOR BIKE SHARING, BELIEVE IN IT, THE PUBLIC BIKE TRANSPORT LIVES, AND GROWS, AND THE CITY DOESN'T REJECT IT.

NOT A SERVICE FOR CITIZENS,  
BUT **A SERVICE FOR THE COMUNITY**

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If people aknowledge, recognize, and use it, bike **sharing becomes as a part of the city**, like an organ for an animal body.

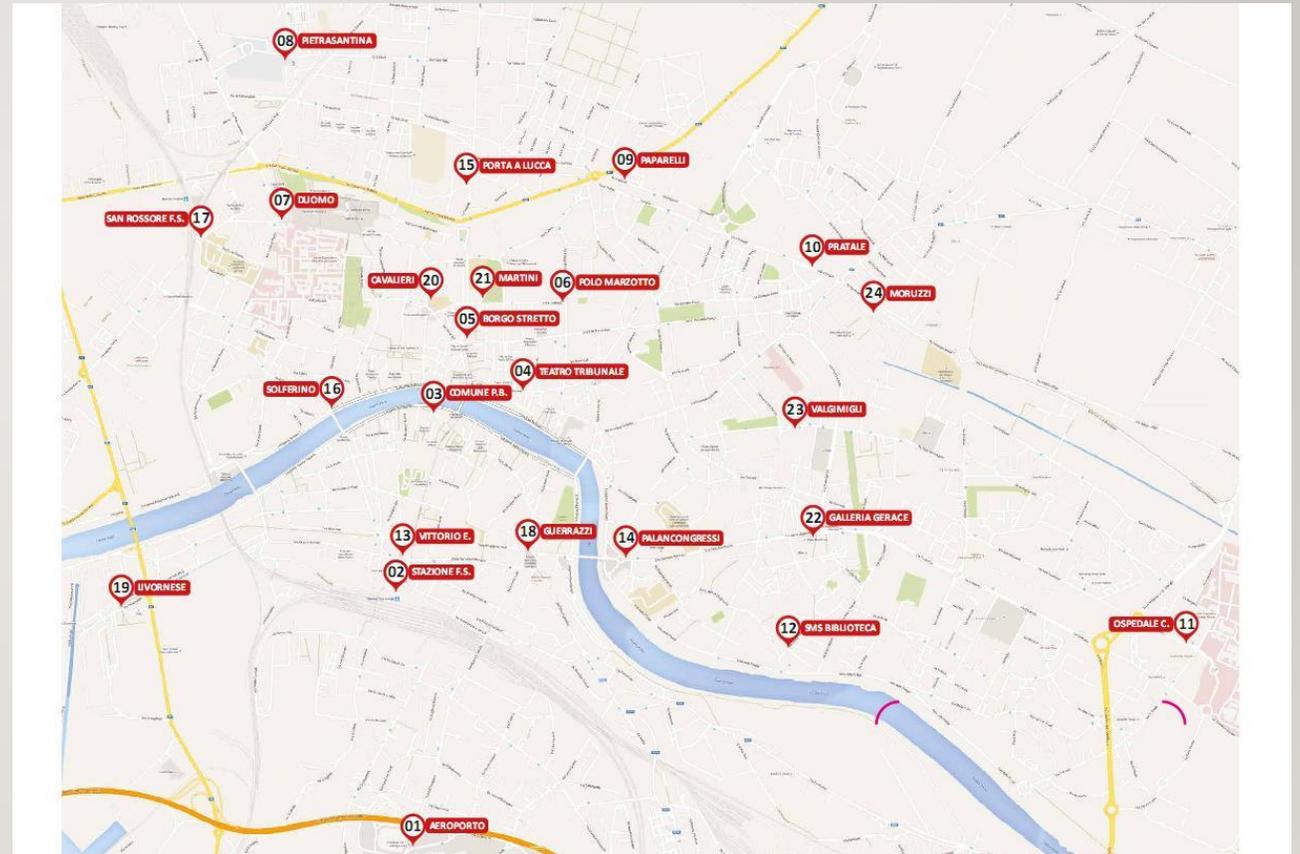
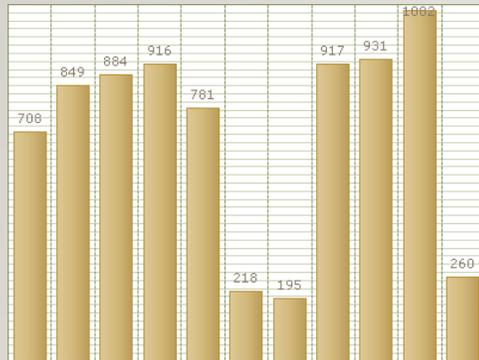
“CARABINIERI” use Ciclopi for plainclothes patrols...

LOCAL POLICE use Ciclopi to move in the city...



WE ARE NOW TO DOUBLE THE INITIAL PROJECT (12 TO 24)

EXPERIENCING A GREAT RATE OF USE (500 – 1000 T.P.D.)



## THE FOLLOWING ARE 2014 DATA FROM SPANISH STUDY ON BS SCHEMES IN SPAIN:

([HTTP://WWW.ELTIS.ORG/DISCOVER/NEWS/NEW-STUDY-BIKE-SHARING-SPAIN-PUBLISHED-0](http://www.eltis.org/discover/news/new-study-bike-sharing-spain-published-0))

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**In 57% of the BSSs, the number of rents per bicycle per day was not higher than 0.25, i.e. bicycles are rented at most once every 4 days. In contrast,**

**14% of BSSs operated more than 3 rents per bicycle per day and bicycles were rented at least once a day in 24% of schemes.**

**We have in Pisa from 5 to 8 trips per bike.**



1130 TRIPS/1000 CIT./YEAR  
KNOWN (A MISTAKE!) AS THE  
BEST RATE IN ITALY (MILAN)

(“LA REPUBBLICA”, 2014)

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WE HAVE IN PISA 1623  
trips/1000 cit./year



30

**Chilometri orari**

È il limite di velocità urbana indicato in una proposta di legge che è appena stata incardinata nel ddl di riforma al Codice della Strada in discussione alla Camera

1,4

**Millioni**

Sono per l'esattezza 1.426.724 i prelievi delle biciclette con il bike-sharing a Milano, pari a più di 1.130 prelievi ogni mille abitanti. È il numero più alto in Italia

ramente non ricompa-  
re in bici — attività g-  
evita il furto — vien  
Nel dossier Sviste Cicla-  
sto, si spera, online —  
mente una classifica c-  
cliste: prime Bolzano  
Ferrara. C'è una prop-

**La classifica**

In testa alla graduatoria delle città dove ci si sposta in bicicletta ci sono Bologna e Pesaro, seguite da

parla da tempo, che alla lista italianissima si è pressiva, ma è cruciale mettere il limite di velocità nelle aree urbane a 30 chilometri (altrove è così; altrove provenienti sia da destra che da sinistra, devono dare la precedenza alle bici). C'è un invito a partecipare alla festa dei ciclisti Love, oggi a Roma, con un riferimento alle 15 a piazza del Comune (alle 15 con questo calcolo che l'anno prossimo si festeggerà a maggio? Ma per l'anno prossimo si tentare di ottenere qualcosa in meno delle ciclabili a colori dipinte con una striscia che poi son quelle che fanno no meglio, nel mondo? Il vero).

© RIPROD.

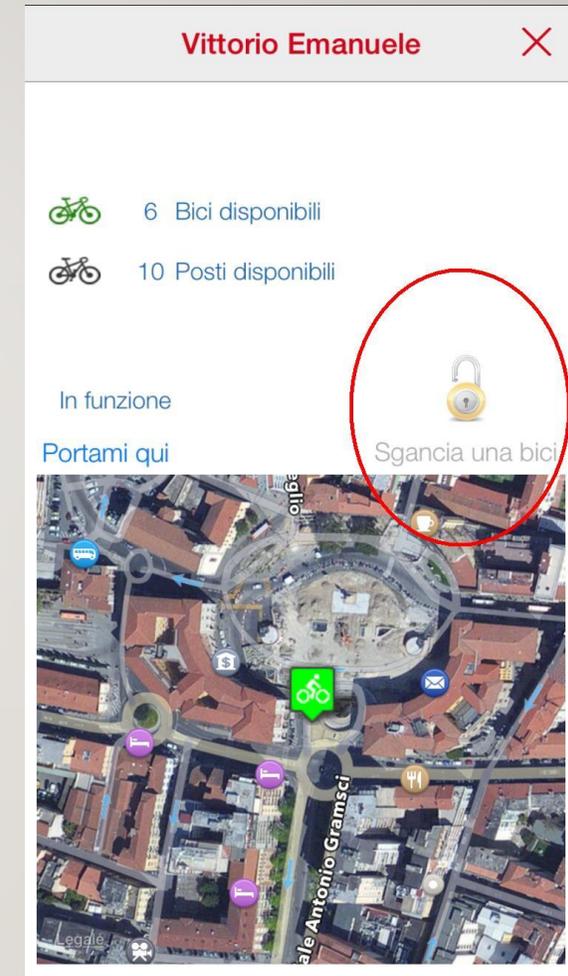
VERY USEFUL APP FOR SMARTPHONES (NAMED *CICLOPI*)

TAKE YOUR BIKE FROM WHEREVER YOU ARE  
(WITH CREDIT CARD)

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GIVES INFORMATIONS ABOUT BIKES / SPACES  
AVAILABILITY

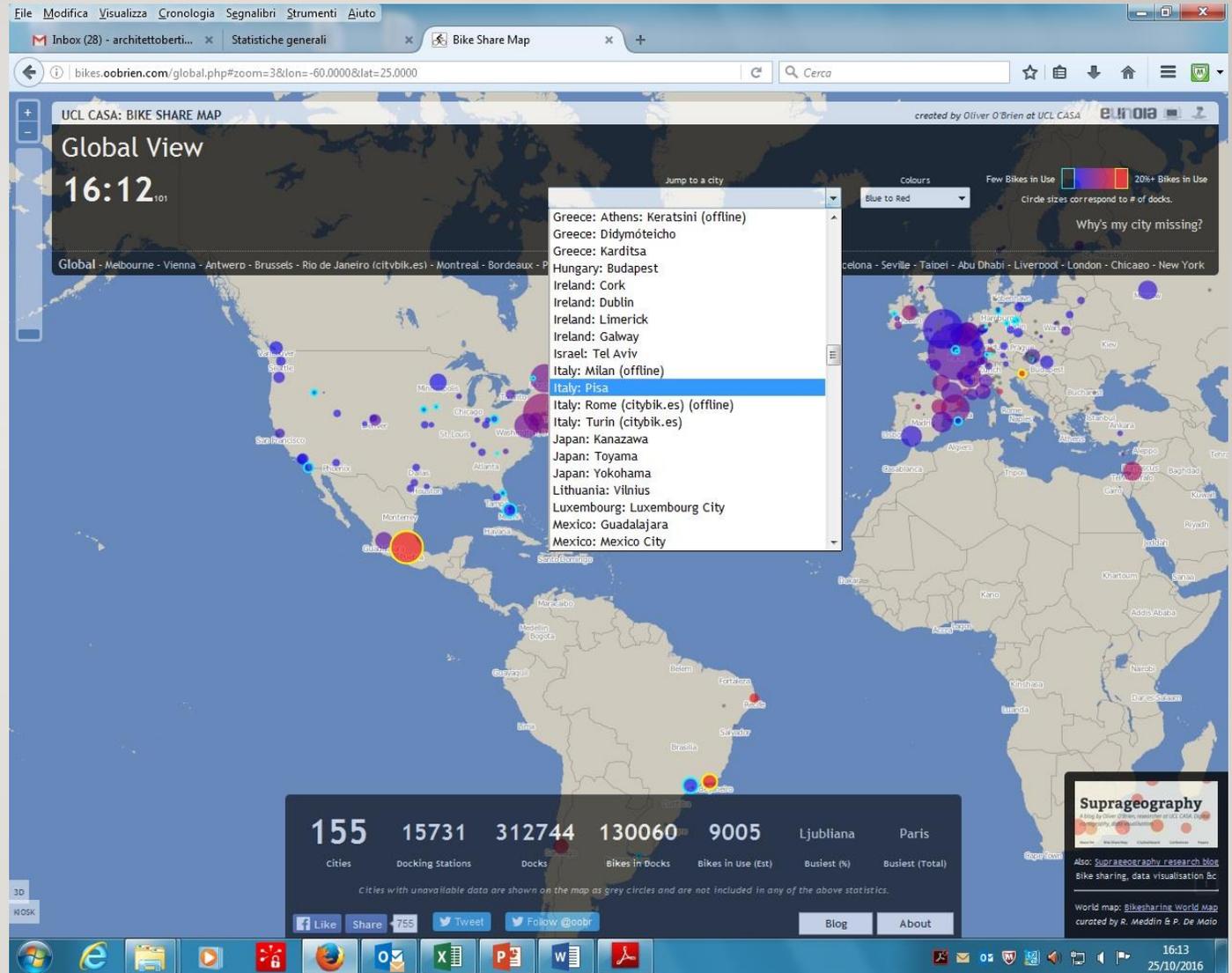
GIVES ALERT TO OPERATORS THAT TRANSPORT BIKES  
FROM FULL TO EMPTY ST.



# LONDON RESEARCHER O'BRIEN PUT ON AN INTERACTIVE WORLD MAP SOME BIKE SHARING SYSTEMS

(videoclip of time variations in docks  
availability is very interesting)

FOR ITALY ARE THERE (only)  
ROMA (out of order),  
MILANO, TORINO, AND **PISA**.



COSTS: 1153 \$/BIKE, WHEN WORLDWIDE COST IS AVERAGE 1500-2500 \$/BIKE

(SOURCE:

[HTTP://WWW.EPOMM.EU/NEWSLETTER/ELECTRONIC/1012\\_EPOMM\\_ENEUS\\_IT.PHP](http://www.epomm.eu/newsletter/electronic/1012_epomm_eneus_it.php))

WHERE DO WE TAKE MONEY FOR THIS?

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LOCAL AGENCY FOR MOBILITY (where Bike Office lives) collects money **from private car parking** AND PAYS FOR BIKE SHARING average 150'000 euros/year



ZERO BIKES STOLEN      IN FOUR YEARS

ZERO BIKES (SERIOUSLY) DAMAGED

EVERYBODY LOVES CICLOPI !

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PISAMO srl

(Pisa's Municipality mobility agency)



GREETINGS

FROM PISA