

THE SHARED BICYCLE SCHEME IN MILAN: A REPORT ON THE DEVELOPMENT
OF A SUCCESSFUL PUBLIC TRANSPORT SYSTEM

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SOMMARIO

Negli ultimi anni il numero dei sistemi di *bike-sharing* pubblici è aumentato enormemente in tutto il mondo, soprattutto nelle metropoli. Le amministrazioni comunali ormai considerano il *bike-sharing* una reale opportunità di successo per la gestione del traffico cittadino. Per un paese come l'Italia con enormi problemi di gestione della mobilità urbana il *bike-sharing* pubblico può rappresentare una valida soluzione a disposizione dei cittadini per gli spostamenti brevi in aree altamente urbanizzate. In questo lavoro si analizza il sistema *BikeMi* del Comune di Milano (che sta avendo un notevole successo e che sta pienamente soddisfacendo sia il management della società di gestione, sia l'amministrazione comunale, ma soprattutto i cittadini) sulla base di un *dataset* contenente 4.1 milioni di itinerari in bicicletta percorsi dagli utenti, registrati tra il 2009 e il 2012. Da questa analisi si può concludere che per un utente medio la bicicletta è ormai una valida alternativa all'automobile nel centro città in termini di velocità, distanza percorsa giornalmente e possibilità di scelta di itinerari alternativi, specialmente nelle ore di punta e in prossimità del centro storico e delle stazioni ferroviarie. I principali *hotspot* di utilizzo del servizio sono localizzati maggiormente nella parte settentrionale del centro storico e nelle vicinanze delle stazioni ferroviarie.

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1. INTRODUCTION

In the last years, the growth of urban population combined with the increase of traffic congestion, environmental pollution and fuel prices have driven urban developers and city councillors to experiment new sustainable mobility systems, including Public Shared Bicycle Systems (PSBSs). This phenomenon is having important consequences in terms of employment, public and private investments and citizen approval. Cycling is attracting renewed attention as a mode of transportation that is both environmentally friendly and beneficial for human health (Pucher et al., 2010), but also as a valid alternative to the car in highly congested cities. With the spread of the economic crisis of the last five-six years, socioeconomic factors are increasingly emerging as major determinants of bike usage together with other “traditional” factors like meteorological conditions, season and weekday usage (Smith and Kauermann, 2011).

Previous literature on cycling has focused on social and health benefits, but data limitations have often produced unsatisfactory results. Nowadays, the development of PSBSs for the general public is forcing managers and decision makers to develop increasingly sophisticated management systems based on GPS automated software, satellite control and automated bike docking stations, paving the way for the production of a huge amount of data. This new scenario offers the opportunity to perform up-to-date evaluations of the effects of PSBSs on urban transport systems that are useful for key changes in transport and environmental policies and for the quality of life in urban areas.

Among common features of PSBSs are: (i) a shared pick-up mode with easy-to-access docking stations conveniently distributed in the urban area; (ii) an unrestricted usage in terms of origin and destination; (iii) penalties imposed for misuse. However, there are also differences. For example, business models adopted to manage the service differ from context to context, ranging from completely public to completely private systems, with public-private mixed forms largely more popular. Involved operators include local governments, public transport agencies, advertising companies, for-profit and non-profit groups (Midgley, 2011; Shaheen et al., 2010). Some PSBSs are integrated with bus and underground public transport systems, some are not. The success of a PSBS depend obviously on many variables, but, above all, it changes over time, so that a continuous monitoring is needed (Lathia et al., 2012).

The *BikeMi* PSBS in Milan is not exception, being the biggest and most innovative system in Italy and presenting many specificities and differences with other PSBS. In this paper we outline its main features and make comparisons with other PSBSs in Europe, especially in terms of speed and traffic volumes. Section 2 is devoted to a brief outline of the main characteristics of *BikeMi*. Section 3 presents a short portrait of an average user, whereas Section 4 shows a short description of the evaluation of the system in terms of speed and more used bike paths in the city. Section 5 presents some results of a model for average

card is issued for free, but its re-issuing cost is 5 Euros. The first 30-minute usage is free (a common policy for SSBS systems), with a subsequent fare increase based on blocks of 30-minute increments. Subscription is suspended after 3 missed returns with a maximum fine of 150 Euros.

The *BikeMi* database is provided and maintained by the managing company Clear Channel. The dataset used in this work contains information on all trips that occurred daily between December 1, 2008 and December 31, 2012. Some data are available also for 2013. Every record in the dataset provides details on departure and arrival times, the geographic area covered and the identity of the user.

From 2009 to 2012, both the number of stations (red vertical bars in Figure 2) and the average number of daily journeys (blue vertical bars in Figure 2) have considerably increased, the first from around 110 to around 160, the second from almost 2,000 to almost 4,000. During traffic congestion events like public transportation strikes or political rallies the number of daily journeys usually doubles.

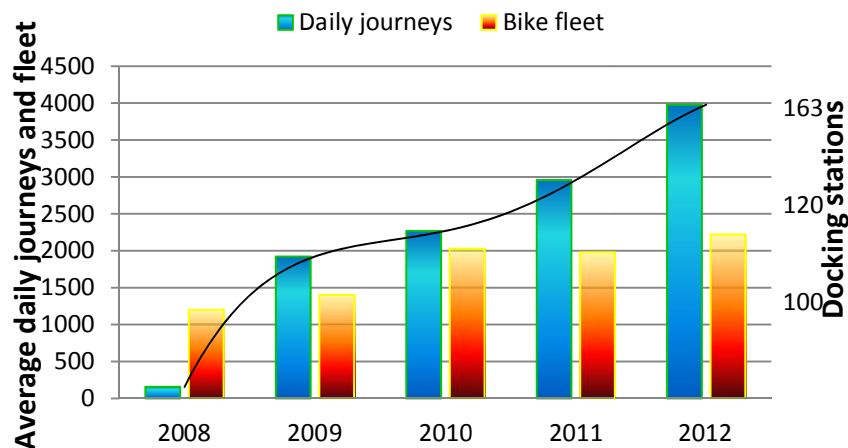


Figure 2 - Number of daily journeys and stations (2008-2012). The black line represents the number of available stations. Data for 2008 are only for December

3. THE AVERAGE *BIKEMI* USER AND HER/HIS CYCLING BEHAVIOUR

The form used for the *BikeMi* subscription request contains questions about some users' personal details. According to the data resulting from the answers to these questions, the average profile of a *BikeMi* user is a 41 year old, male professional, who uses the *BikeMi* bicycle to go to work for the last mile of his daily commuting journey (Figure 3).

61.6% of the subscriptions are men, and 48.4% women. Male users' average age is 42 years, female users' average age is 38 years. The majority of subscribers are managers or consultants/entrepreneurs (26.53% of managers among male respondents and 19.87% among female respondents; percentages are a little higher for consultants/entrepreneurs – see Figure

3). Students are 5.88% of the customers, whereas pensioners are only 1.66%. Lastly, Figure 4 shows the users' distribution according to their current postcode. It can be noted that the service attracts a high percentage of commuters (more than 25%) outside the Milan urban area.

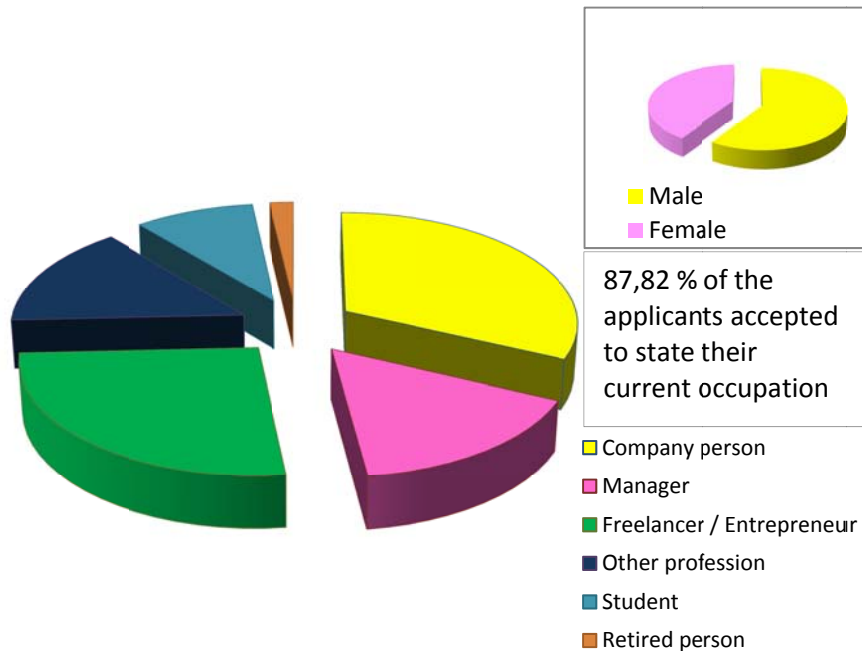


Figure 3 - BikeMi users' characteristics (2008-2012)

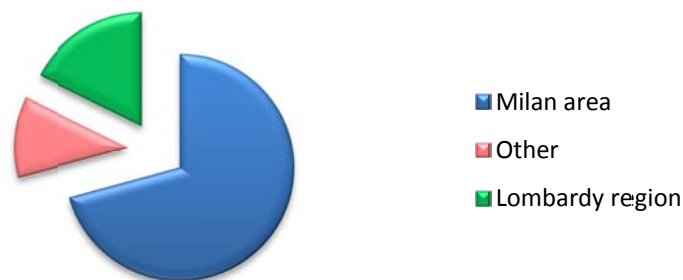


Figure 4 - Users' current residential address distribution (Dec. 2008-2012)

During peak periods the bike traffic converges more intensively towards docking stations situated in central areas. Peak-period traffic has increased more than other day periods during the years (Figure 5). Three peaks can be noticed: the first one is at 8AM with more than 250,000 journeys in 2012; the second one at 1PM with almost 140,000 journeys in 2012 and the third one at 6PM with almost 200,000 journeys in 2012.

On average, in 2013 each bicycle was used almost twice per day, whereas it was used only once per day in 2010 (Figure 6).

The most important stations in terms of usage are those in the very city centre (see again Figure 1) where pedestrian areas are located. The stations in Duomo square, Cadorna square and San Babila square (all central locations) have registered more than 20,000 check-ins in 2010 (area in red in Figure 1). Other areas near these central locations situated in transport interconnection points (areas in yellow in Figure 1) registered between 10,000 and 20,000 check-ins in 2010. Other important locations are those near the main railway stations.

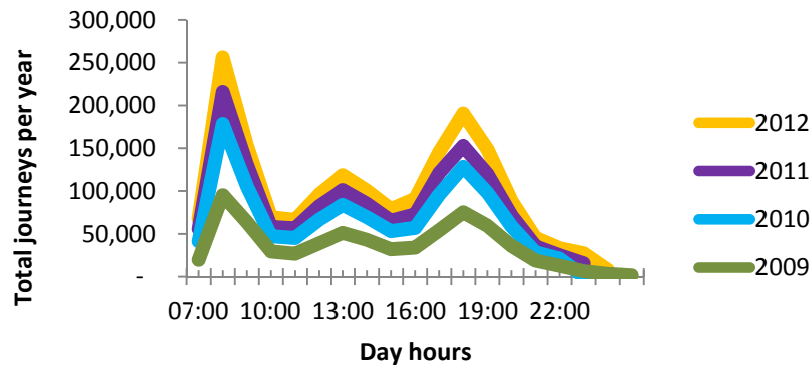


Figure 5 - Total number of journeys per period of the day (2009-2012)

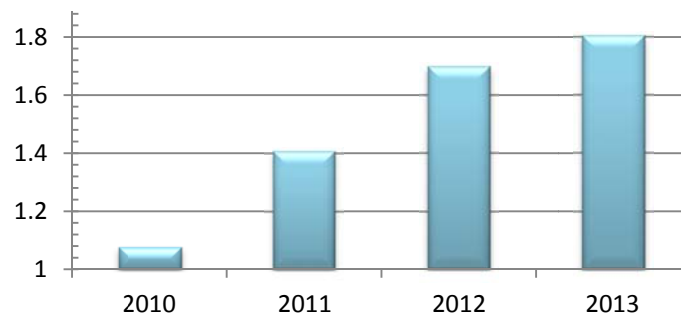


Figure 6 - Average daily journeys for each bicycle (2010-2013)

4. THE AVERAGE *BIKEMI* USER AND HER/HIS CYCLING BEHAVIOUR

The available dataset allows for a thorough analysis of cycling speed³ and users' preferred itineraries. During winter, cyclists' average speed reaches higher values than during warmer months. Figure 7 shows the cyclists' main patterns of travel which often result to be in correspondence of pedestrian paths and bus/tram lanes. Many of these paths are along the

³ No speedometer or distance counters has been installed yet on *BikeMi* bikes. In our analysis, the distance of a bike trip is estimated with the use of some software applications. The GPS coordinate position of each bike station is determined through Google online services, namely the "Google Distance Matrix API" service that provides travel distance and time for a matrix of origins and destinations by returning an XML report of the results, which, through a C++ string, is sent to a matrix-like dataset, which is finally stored in a CSV file.

wrong direction of one-way streets therefore suggesting that cyclists use sidewalks intensively all around the three main city centre traffic hubs: San Babila square, Duomo square and Cadorna square. Travel destinations are concentrated in the Milan congestion charge area or close to its boundaries and in city neighbourhood lacking underground and other main public transport facilities. Short journeys within 500 meters from the starting point (journeys are often included within 2 km) are numerous, probably as an alternative to walking. The average walking distance to find a car park in central Milan is in the order of 200m which is similar to that of the closest *BikeMi* station, but finding a car park space is also generally more difficult than finding an empty *BikeMi* slot. The combination of these elements may explain the doubling of the number of *BikeMi* cyclists since the start of the scheme. These findings are of great importance, considering that these bike paths are often along streets prohibited to cars due to the congestion charge and that practically there is no waiting time for parking.

Speed is an important quantitative factor in the evaluation of the efficiency of a transportation system. Maximum speeds, achieved by a few individuals, are always between 19 and 24 km/h average, with peaks levels of 27 km/h in the morning periods. Indeed, highest speeds are reached almost always in the morning, when customers are in a hurry to get to their workplace, more than when they have to return home in the evening. Thence, although the overall average speed is 9 km/h, the upper decile is over 12 km/h (Figure 8). In the morning rush hours, cyclists' average speeds - in normal conditions and for average users - is 13.5 Km/h. These average speeds are close to those of other European cities, and in many cases lower than those of cities of similar dimension. For example, for Lyon, France, the averages are around 18 Km/h and 12 Km, respectively (Jensen et al., 2010), but Milan has one of the world's highest rate of car ownership, is one of Europe's most polluted cities and has one of the lowest average car speed (22 Km/h for the whole urban area which comprises highways, according to the last report commissioned by ANCI, the Italian Association of City Councils (Cittalia, 2009)). During weekdays, in months with the highest bicycle usage (i.e. September and October), the average speed reaches about 10 km/h and the upper decile is more than 13.5 km/h. Cyclists' average speed reaches a peak of 9.5 km/h during the early hours of weekday mornings, when the traffic flow is more fluid. When there is less need to hurry, the average speeds fall to 8 km/h as in weekends and afternoons.



Figure 7 - Main cycling paths (highlighted in orange). The radius of the orange circles around the stations are proportional to the total number of trips. Other circles in red, light green and dark green represent Milan's underground stations. The light green area is the congestion charge area (Source: 2012, Clear Channel dataset and pedalami.it website)

Bike traffic is therefore an important component of nowadays urban transportation systems. Strategies to reinforce these systems can be adopted by first of all considering the number of docking stations with no bicycles available as well as users' main paths.

If journey data do not provide sufficient details about specific routes taken by customers, on the other hand distances and usage time can be easily calculated through hire and drop-off points information.

From these data it appears that commuters use the *BikeMi* bicycles to move over around 300 meters on average, while they hardly travel longer distances. Furthermore, most of the journeys are shorter than 30 minutes (Figures 8, 9, 10).

Figures 9 and 10 also show the distances carried by users, and the journeys' time lengths. It can be noted (Figure 11) that the *BikeMi* usage grew consistently over the years. The majority of users (97.4%) use the bicycle for a period less than half an hour due to the additional charge above 30 minutes, while only a fraction of them use the bicycle for longer periods. However, journey data do not provide details about specific routes and personal behaviour by customers. Therefore, in the future, a customer care survey should be implemented, in order to explore and learn more about user's behaviour.

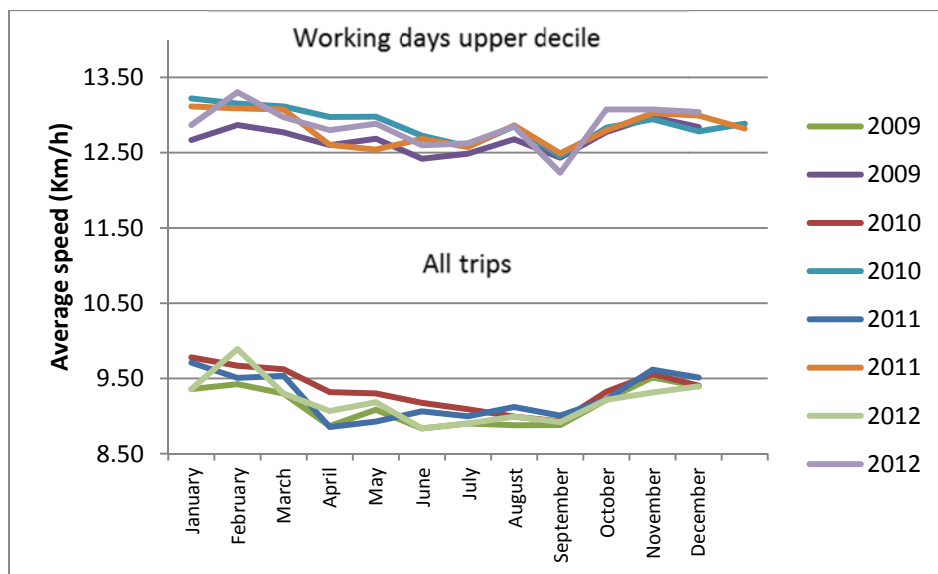


Figure 8 – Monthly Average speed on weekdays and for all trips (2009-2012)

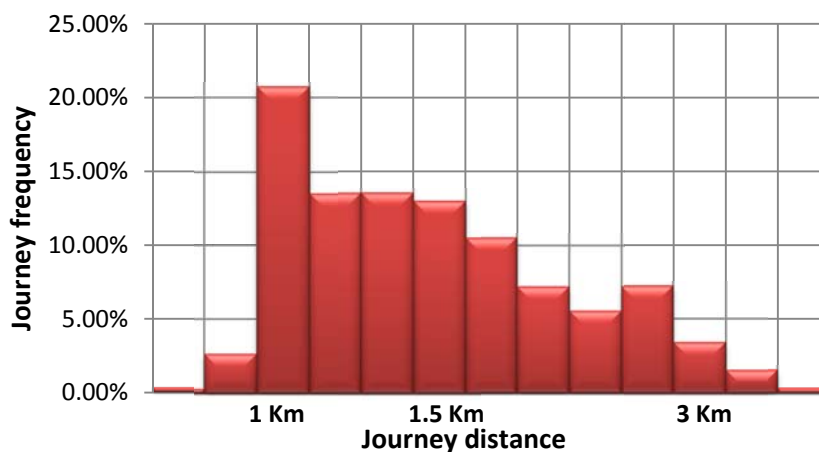
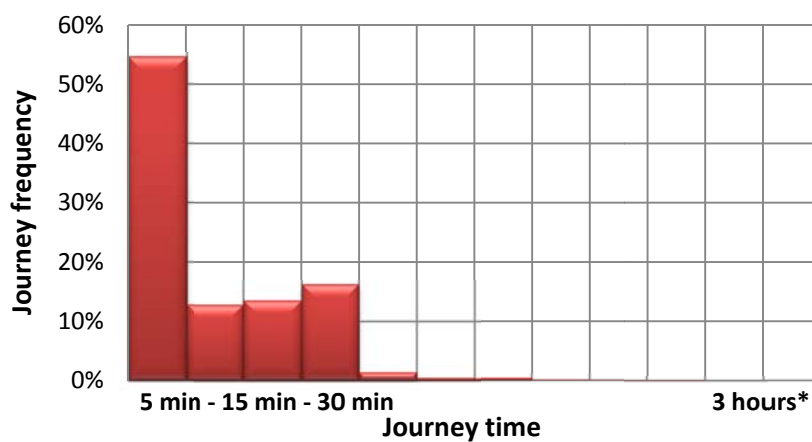


Figure 9 - BikeMi distance frequencies during the warm season (2009-2012)



* Journeys longer than 3 hours are excluded being users wrongdoings in checking outs.

Figure 10 - BikeMi renting time length during the warm season (2009-2012)

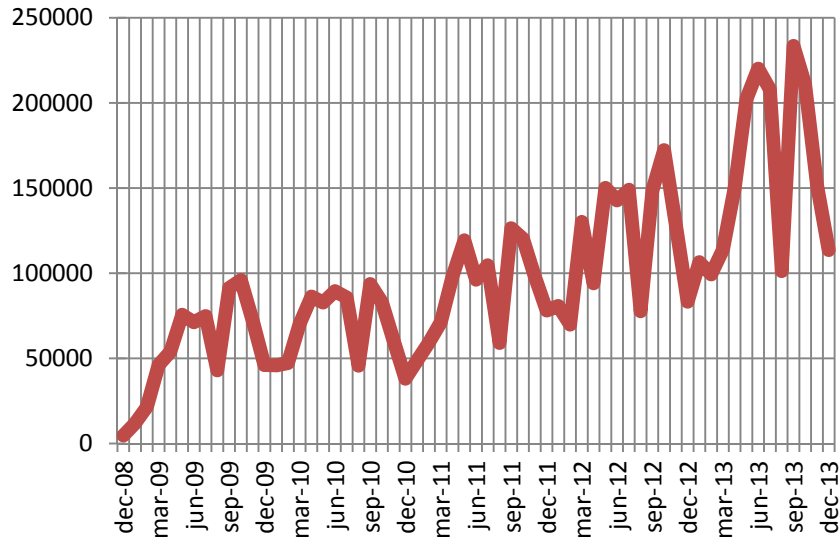


Figure 11 - BikeMi total journeys (2009-2013)

5. DETERMINANTS OF THE BIKE USAGE

In this section our purpose is to model counts of bike check-ins and check-outs throughout the docking stations inside the Spanish walls (also called “Bastioni”, centred in the Duomo square – around 8.2 Km², about 4.5% of the whole Milan municipality area), in order to find the most important associations between bike usage and public transport characteristics of the areas where docking station are situated.

We chose the “Bastioni” area since it corresponds to the traffic restricted zone introduced in Milan since January 2008. We model counts separately at each hour of the day⁴ and separately for check-ins and check-outs from 7AM to 8PM, resulting in twenty-six distinct models. This hourly analysis allows to check for time pattern of usage during the day. Predicting variables chosen to explain the counts variability are: (i) the presence of a railway station in the vicinity (1 if present, 0 otherwise); (ii) the number of underground lines; (iii) the number of bus lines; (iv) the number of tram lines; (v) the distance in Km from Duomo square; (vi) the suburb location (1=Northern area; 0=Southern area). Counts were those of May 2010 which is almost in the middle of the three-year period to which the dataset is referred and can be well representative of a fully working period with no other festivities and no other particular events influencing the normal usage.

Table 1 presents some station characteristics in terms of distance from the city centre (ranging from 0 to 2 Km) and suburb location (15 stations out of 19 are situated in the northern area), together with average counts of bike check-ins and check-outs across three-hour intervals in May 2010. The maximum check-in value occurs in Porta Venezia (where one railway station,

⁴ We excluded Saturdays and Sundays.

two underground lines, five tram lines and one bus line are located – see Table 2 for details of the number of public transport lines in docking stations’ neighbourhood) at 5-8PM (33.13 average count). The maximum check-out value occurs in Cadorna (having one railway station, two underground lines, two tram lines and four bus line in the immediate vicinity) at 7-10AM (53.78 average count).

5.1 Poisson regression model on bike check-ins and check-outs

Poisson regression is one of the most important regression methods to model count data (Cameron and Trivedi, 2013). The assumption is that counts y_i (i.e. the number of occurrences of the event of interest for the i -th observation – in our case the number of check-ins and check-outs) are Poisson-distributed given the vector \mathbf{x}_i of linearly independent regressors that explain the variability in y_i . For each i of n observations the basic Poisson model gives the distribution of y_i given \mathbf{x}_i :

$$f(y_i|\mathbf{x}_i) = \frac{e^{-\mu_i} \mu_i^{y_i}}{y_i!} \quad (1).$$

The mean parameter μ_i is such that $E[y_i|\mathbf{x}_i] = \mu_i$. In the log-linear version the mean is parameterized as follows, with $\boldsymbol{\beta}$ representing the vector of the regression coefficients:

$$\mu_i = \exp(\mathbf{x}_i' \boldsymbol{\beta}) \quad (2).$$

Equations (1) and (2) simultaneously define the Poisson regression model.

5.2 Results

Table 3 reports the results of the Poisson regression analysis. The sign of the variable representing the presence of a railway station variable is always positive (apart from check-ins in the 7AM-8AM period) and significant (apart from check-outs at 5PM-6PM). Moreover, from early hours to late hours the magnitude of its coefficients increases for check-ins and decreases for check-outs. This means that the service is used mainly by commuters from outside Milan arriving in the morning and leaving in the evening, confirming the fact that *BikeMi* service is strongly used not only by Milan residents but also by Lombardy region residents (see Figure 4) intending to reach working sites near the railway stations.

Surprisingly, other transportation modes have a negative effects on the usage of the service. This can be justified by the fact that Milan has one of the best underground network in Italy with four lines and other 10 suburban train lines, and also good bus and tram networks. Therefore, a widespread transport service is insured for the users in the city centre, and cycling is still too far to be a successful competitor in this sense. As expected, bike usage is higher as the distance from the city centre increases and in the northern part of the city.

Table 1 – Location and spatial characteristics of stations, bike check-ins and check-outs average working day hourly counts

Period: May 1st, 2010-May 31st, 2010						
Station characts			Average hourly counts (first row: check-ins; second row: check-outs)			
Docking station	Distance to the city centre (Km)	Suburb location	07:00-10:00	12:00-15:00	17:00-20:00	07:00-20:00
Duomo	0	North	15.21	9.65	29.52	10.24
San Babila	0.75	North	6.21	11.54	17.16	10.08
Cadorna	1.26	North	11.77	8.61	7.22	8.30
Corso Italia	0.96	South	6.01	9.26	13.70	8.46
Sant'Agostino	0.95	South	4.81	8.83	28.61	12.19
Arco della Pace	2.00	North	53.78	7.57	5.94	17.32
Regina Margherita	1.92	South	6.01	3.54	4.06	3.82
Cinque giornate	1.64	South	4.25	3.52	5.96	3.86
Tricolore	1.59	North	4.52	2.57	5.57	2.76
Porta Venezia	1.88	North	5.33	2.71	2.25	2.97
Moscova	1.66	North	2.68	3.42	7.49	3.74
XXV Aprile	1.95	North	7.64	3.19	4.04	4.27
Cadorna 2	1.24	North	0.70	1.25	3.10	1.55
Brera	0.95	North	3.04	3.70	4.17	1.61
Fatebenefratelli	1.22	North	3.35	3.64	5.83	3.85
Cavour	1.17	North	4.32	3.06	4.13	3.51
Meda	0.52	North	2.19	3.42	5.88	3.49
Cusani	0.63	North	6.54	3.67	3.51	3.98
Cairoli	0.70	North	2.94	4.91	33.13	5.45
			10.10	4.12	4.64	5.61
			3.87	4.41	5.91	4.23
			5.13	4.52	5.75	4.52
			2.41	3.01	10.04	4.35
			11.94	3.35	4.26	5.15
			1.45	1.62	7.23	2.91
			9.48	1.29	1.71	3.27
			5.36	2.84	3.93	3.33
			1.97	3.51	5.12	3.09
			8.15	2.45	1.59	3.32
			1.83	2.88	5.93	2.91
			7.99	4.48	2.45	4.23
			1.30	4.75	7.01	3.77
			9.78	4.54	3.01	4.79
			0.77	5.61	8.86	4.46
			6.42	3.07	1.57	2.98
			1.07	3.17	5.59	2.78
			4.17	4.35	4.33	3.92
			3.39	4.25	5.45	3.89

Note: for each station the average counts for check-ins are displayed in the first row, the average counts for check-outs are displayed in the second row.

Table 2 – Station connections with other public transport facilities

Docking station	No. of tram lines	No. of bus lines	No. of underground lines	Rail stations	Other	Total
Duomo	7	0	2	0	0	9
San Babila	0	7	1	0	0	8
Cadorna	2	4	2	1	1	10
Corso Italia	5	3	0	0	0	8
Sant'Agostino	2	1	1	0	0	4
Arco della Pace	5	4	0	0	0	9
Regina Margherita	3	3	0	0	0	6
Cinque giornate	4	4	0	0	1	9
Tricolore	2	3	0	0	1	6
Porta Venezia	5	1	2	1	1	10
Moscova	2	2	1	0	0	5
XXV Aprile	1	1	3	1	1	7
Cadorna 2	2	4	2	1	1	10
Brera	4	2	1	0	0	7
Fatebenefratelli	3	0	1	0	0	4
Cavour	1	3	2	0	0	6
Meda	1	7	1	0	1	10
Cusani	7	6	1	0	1	15
Cairoli	7	6	1	0	1	15

Table 3 – Poisson regression coefficients on bike average check-ins and check-outs

Independent variables	Check-ins												
	7-8	8-9	9-10	10-11	11-12	12-13	Hours 13-14	14-15	15-16	16-17	17-18	18-19	19-20
Intercept	3.43***	6.22***	6.33***	5.651***	4.64***	5.02***	5.25***	5.87***	5.57***	5.76***	6.15***	6.37***	6.35***
No. of railway stations	-0.46**	0.08	0.28***	0.53***	0.41***	0.64***	0.75***	1.54***	1.75***	2.20***	2.81***	2.55***	2.36***
No. of underground lines	0.54***	-0.04	-0.22***	-0.21**	-0.08	-0.06	-0.12**	-0.36***	-0.44***	-0.42***	-0.46***	-0.64***	-0.71***
No. of bus lines	-0.01	-0.03***	-0.05***	-0.05***	-0.02	0.02	-0.02	-0.03**	-0.03**	-0.03**	-0.02	-0.05***	-0.09***
No. of tram lines	-0.06**	-0.09***	-0.07***	-0.06***	-0.03**	-0.04***	-0.04***	-0.06***	-0.07	-0.09***	-0.12***	-0.07***	-0.05***
Distance	-0.93***	-1.07	-0.99***	-1.08***	-0.57***	-0.65***	-0.64***	-1.03***	-0.85***	-1.11***	-1.14***	-0.75***	-0.64***
Suburb location (1=North)	0.85***	0.70***	0.48***	0.23**	0.39***	0.13	0.54***	0.45***	0.42***	0.45***	0.40***	0.29***	0.14**
AIC	227.6	536.2	491.7	292.6	267.2	305.7	401.0	334.8	373.9	451.2	602.5	781.1	652.0
Deviance	114.6	399.6	357.2	174.3	148.2	182.0	269.9	206.5	250.0	327.9	473.7	645.2	518.7
Independent variables	Ckeck-outs												
	7-8	8-9	9-10	10-11	11-12	12-13	Hours 13-14	14-15	15-16	16-17	17-18	18-19	19-20
Intercept	5.85***	7.91***	6.66***	5.86***	4.54***	5.73***	5.89***	5.04***	4.74***	5.32***	5.35***	6.01***	6.02***
No. of railway stations	4.58***	4.18***	3.02***	2.36***	0.88***	0.80***	0.93***	0.52***	0.66***	0.78***	-0.01	0.19*	0.73***
No. of underground lines	-1.40***	-1.19***	-0.83***	-0.65***	-0.15*	-0.09	-0.24***	-0.07	-0.19**	-0.25***	0.11*	-0.02	-0.14**
No. of bus lines	-0.07**	-0.09***	-0.06***	-0.08***	0.01	-0.05***	-0.03**	-0.02	-0.02	-0.03***	0.01	-0.04	-0.04***
No. of tram lines	-0.23***	-0.20***	-0.10***	-0.09***	-0.03**	-0.08***	-0.08***	-0.03**	-0.02*	-0.04***	-0.06***	-0.06	-0.06***
Distance	-1.02***	-1.18***	-0.98***	-1.09***	-0.57***	-1.01***	-0.96***	-0.62***	-0.60***	-0.75***	-0.75***	-0.89***	-1.05***
Suburb location (1=North)	0.82***	0.27***	0.32***	0.38***	0.43***	0.39***	0.54***	0.52***	0.61***	0.34***	0.43***	0.47***	0.51***
AIC	586.8	1565.3	798.5	281.2	281.1	243.5	311.5	325.4	335.3	301.3	347.8	414.1	364.5
Deviance	480.3	1427.7	666.3	162.7	161.7	117.5	180.2	197.2	212.6	178.0	222.9	284.3	232.1

Note: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

6. CONCLUSION AND FUTURE WORK

This paper has shown that the Milan PSBS has steadily grown during the last years, doubling the average daily bike usage, while the bike fleet, as well as the number of docking stations available, has also increased. One of our main research goal was to detect the most common bicycle paths and analyse the bike journey average speed.

This analysis has also shown that PSBS is a fast and convenient option for short-distance trips in cities, and can play an important role in reducing urban mobility problems in multiple contexts. It can also provide efficient first-last mile connections and end-to-end trips.

Possible policies to promote cycling include the improvement of a safe cycling infrastructure together with the empowering of technical facilities like electronic docking station services and new bike accessories. With the improvement of the service quality, commuting speed and the total amount of distance covered should consequently increase. PSBSs should also contribute to the general efficiency of cycling, which in turn helps improving the urban transportation route structure and reduces carbon emissions, alleviates traffic congestion problems and carries out a sustainable development strategy for urban transportation.

In conclusion, citizens of Milan are increasingly getting used to urban cycling due to this new transport system. Consequently, city council investments in designing bike paths should result improved, having a positive impact on the safety and promotion of bike sharing.

Cyclists' risk perception and weather conditions affect their behaviour. One of our next step will be the analysis of results from a customer care survey recently carried out in order to understand users' behaviours, perception of the PSBS quality and commuters' needs. Preliminary results from this surveys shows interesting features regarding the preference of customers. For example, the introduction of pedal-assisted bikes would favourably be welcomed by customers, with almost 40% even willing to pay more for this.

Future research into PSBSs operating in big cities like Milan, might preferably include the analysis of existing urban planning, such as pedestrian-cycle reserved tracks or commuters facilities for daily bicycle usage. There is already a huge amount of research which deals with topics like the quality of facilities, safety and environment improvements from SBSs. These studies reveal the existence of several issues, which could be investigated further, so as to obtain a more comprehensive picture of the complexities related to development of these transport schemes. New instruments like data mining analysis and relatively new methodologies like meta-analysis should be used in order to dig into the evidence and help urban planners to make prompt decisions for a balanced development. Some improvements of the modelling of bike counts is also needed. First, the analysis should be extended to the entire parking lots and urban areas and the dichotomous variable "congestion charge area" should be introduced among the independent variables. The effect of the 30-minute free bike renting should also be fully investigated. Second, rather than modelling using stations as observations, an analysis with days as observations and meteorological variables and other

time-dependent determinants like fuel prices or the number of strikes or public area restrictions should be considered in order to predict future bike usage.

Another issue to be further analysed is the *BikeMi* business model which seems to be very successful for all the actors involved: the city council, the advertising company and ultimately the final customers. Accordingly, future research regarding shared bicycle systems should concentrated on examining the potential of advertising for the procurement of public transport services to private companies as well as non-profit business models, such as cooperatives and citizens associations, capable of managing the PSBS in little towns and villages.

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ABSTRACT

In the last years, the number of public shared bicycle systems (PSBSs) in big cities has steadily increased all over the world. City councils now consider bike sharing a valid transport policy option for regulating the urban traffic flow. For a country like Italy with chronic urban development flaws, PSBSs can represent a solution in the hands of citizens for short journeys in highly urbanized areas. In this paper we focus on the successful example of Milan's *BikeMi* PSBS which is giving positive results in terms of satisfaction to the service management, the city council and the citizens. Data concerning 4.1 million bike trips from 2009 to 2012 are analysed. From this analysis it can be inferred that for an average commuter the bicycle is now a valid alternative to the car in terms of speed, distance travelled daily, and itinerary choice, especially during peak periods and in proximity of the city centre and the main railway stations. The main bicycle tracks and hotspots are also detected revealing an imbalance between the northern and the southern part of the city, with the northern part more covered by the service.