A sustainable parking scheme to balance mobility demand in urban areas

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SOMMARIO

Parking policies are considered a principal tool for managing parking demand as well as the negative impacts of private mobility in urban areas such as traffic congestion, air quality, land use, etc.). The paper discusses the role of parking pricing strategies, as complementary tool in order to balance the modal split among private car, public transit and active modes. It suggests the development of a selective parking strategy which basically depends on the accessibility to the alternatives to the private car usage. The accessibility to these alternatives, both at the origin and destination, defines the parking fee of the proposed model. With attention to this study, the distance to the underground lines have been used as proxy for the accessibility to the alternatives in order to compute a more equal parking fee. The aim of the study is to underline a methodological and practical approach which may be developed by policy makers in order to affect drivers' behaviors. The relevance of the parking strategy is illustrated mainly by spatial analysis and the city of Milano is the test area where the pilot study has been conducted.

1. Introduction

Parking pricing strategies are widely used as Travel Demand Management in cities which have to cope with congestion (D'Acierno et al., 2006). Parking pricing policies have been introduced in areas where the demand for parking space has outgrown the supply. According to Shoup (2004, 2005), in absence of parking fee, drivers compete in their search for scarce on-street parking space contributing to generate more traffic. After a critical point, where there is no more parking space available, drivers just cruise in search for a parking space wasting time and fuel, generating more congestion, and they also contribute to pollute the air. These are external costs that motorists cause to a third part and for which they do not pay (Blauwens et al., 2002). These externalities are also known as social costs and the sum of them with the private costs defines the social marginal cost. Thus, the drivers do not take into account the social costs during the decision-making process, but just the private costs, and as consequence this cause the failure to internalize external costs. By setting a price, the cars flow becomes more manageable, due to the demand reduction (Shoup, 2004, 2005; Mingardo et al., 2009), it is a way to internalize the externalities and in the case of positive externalities to give to people a subsidy (Runhaar, 2001).

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According to several scholars (Verhoef at al., 1995; Ferrari, 1995, 1997, 1999; Pompili, 1996; D'Acierno et al., 2006; Marsden, 2006; Mingardo et al., 2009) the main argumentation, supporting the introduction of parking pricing strategies in urban areas as economic tool, is to shift user mode choices towards public transit in order to reduce the congestion and therefore to contribute to enhance sustainability in urban areas. Furthermore, their application requires lower investment costs, without using advanced technologies and with an higher common acceptability than road pricing strategies (Pompili, 1996; Ferrari, 1995, 1997, 1999; D'Acierno et al., 2006; Mingardo et al., 2009). Despite several evidences on parking pricing benefits (Pucher,1993; Kain 1994; Blauwens et al., 2002; Shoup, 2004; Marsden, 2006 Mingardo, 2009; Waerden et al., 2009), policy makers are quite hesitant in introducing restrictive parking pricing mainly for political consensus and equity reasons. Indeed, the effects of parking pricing go beyond the boundaries of the urban mobility shaping the socio-economic morphology of cities (Martinotti, 1993; Colleoni, 2008). For instance, the accessibility can be greatly reduced by setting parking fees (D'Acierno et al., 2006; Waerden et al., 2009, 2011). Thus, the effects on urban mobility have to be investigated in order to optimize transportation systems performance and limiting adverse effects on people accessibility and the economic performance of cities (Pucher,1993; Kain, 1994; Pompili, 1996; Mingardo, 2009; Waerden et al., 2009, 2011). In this project has been proposed a selective parking strategy which takes into consideration equity and accessibility, as relevant variables, in order to compute the parking fee.

2. The definition of the Origin and Destination Parking System

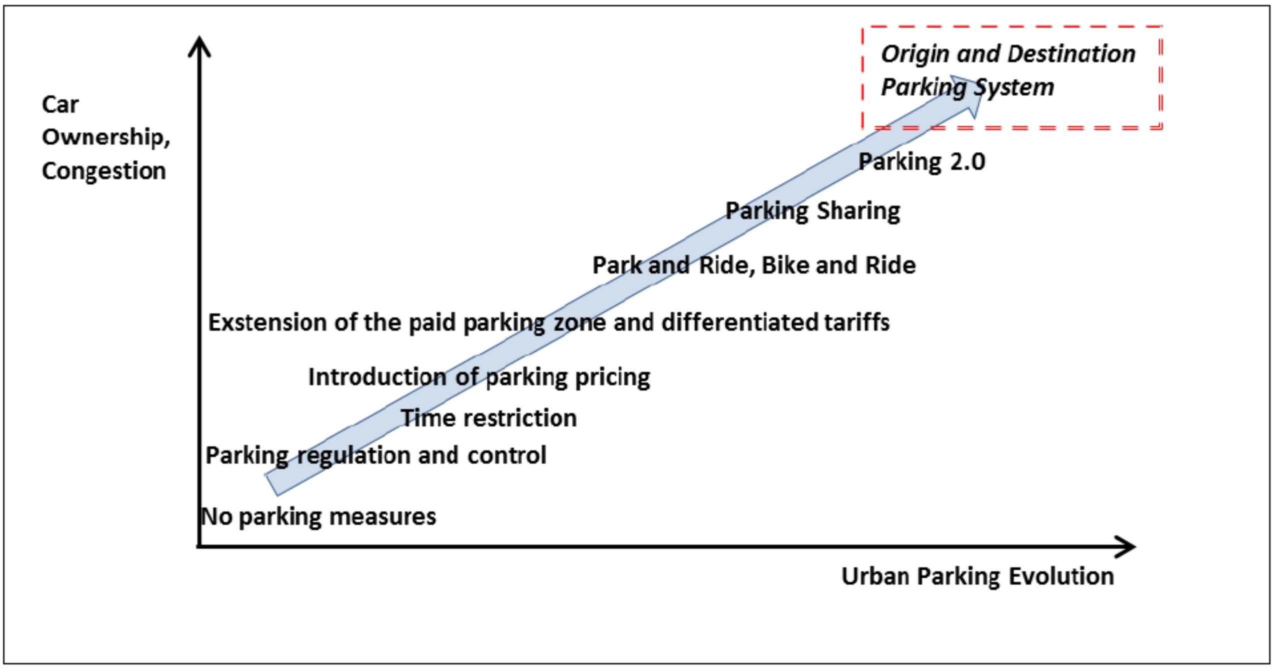
The last century has been characterized by the car system (Dennis et al., 2009). The mass motorization has been the symbol of power and development first in Western world and then in developing countries which has triggered off a consequent and gradual urban growth resulting in the location reconfiguration of the various functions within the metropolitan areas. Thus, residence, work, service, study, consumption and leisure are nowadays increasingly spread over reticular urban areas characterized by increasing mobility flows (Martinotti, 1993; Colleoni, 2008, 2016). Therefore, the automobile reduction, in particular within the cities centre which contributes in reducing the externalities generated by cars, is needed. However, in order to move towards a more sustainable urban mobility pattern it has to be evaluated the efficiency and quality of the alternatives to the private car (May, 1986). Without alternatives there are not effective solutions. In addition to public transit system, slow mobility, sharing mobility and all other mobility choices, as an alternative to car usage, the parking policy represents one of the most effective actions in order to discourage the private car usage (Petiot, 2004; Mingardo et al., 2009). The introduction of on-street parking pricing deals with a set of issues going from individual travel choices to issues including congestion, air pollution and economic vitality. Due to these worries, on-street parking pricing still remains a politically sensitive and yet to-be-tackled issue (Lindblom, 2011; Thompson, 2011; Ottosson et al, 2013; Mingardo et al., 2009). Parking fees play a decisive role into the decision making driver process in everyday life. These decisions concern the generation of a trip, the alternative destinations of a trip and the mode of travel. Probably, no or low parking fee encourages mobility demand and induces drivers to pick their own car (Shoup, 2005; Marsden, 2006; Mingardo et al., 2009).

The study proposes the development of a new parking strategy which assesses the accessibility to the alternatives to the private car usage. The accessibility to these alternatives, as it will be showed below, regulates the parking fees.

Nowadays, motorists pay the same tariffs, independently if there are mobility choices. They pay a flat fee according to the parking pricing framework introduced by the municipality. The price, depending on parking pressure per each area and time, has been set to cope with the externalities. But then, the basic framework considers the parking pressure only taking into account the destination of each trip forgetting the importance of the origin (D'Acierno et al., 2006). Basically, in every city is more expensive to park in the inner city than in other areas and the price does not consider the presence of feasible mobility alternatives to the private car usage. An equalization of parking fees should consider even the origin and not just the destination per each trip in relation to the feasible alternatives to the private car. The Origin and Destination Parking System, the parking pricing policy proposed in this paper, is based on this simple assumption. It avoids a simple flat parking scheme, strictly dependent on the destination area. Rather, it moves towards the introduction of a more suitable pricing scheme which takes a look to new evaluation criteria which policy makers never considered before (D'Acierno et al., 2006; Fistola, 2009).

The scheme proposed in the figure 1 shows the urban parking evolution from absence of parking measure to the most advanced park and ride system. The origin and destination parking policy has the ambition to be the most innovative measure in parking policy and it defines a new concept in parking space regulation. Basically, the idea under this model is to move from a flat parking fee, which is the same for everyone, towards a flexible parking fee. The relevance of the origin per each trip and the features associated to the origin and destination, in order to compute the appropriate parking fare, represent the innovative idea behind this policy. The idea is to build a feasible parking fare depending on the accessibility to the alternative transport mode (the alternative to the car) at the origin and destination per each trip.
The main goal is the congestion reduction in cities by providing a flexible tool, to the local administrations and mobility managers, which is able to estimate a more equal parking fare. Therefore, differentiated parking fees aim to reduce the mobility inequalities, introducing the relevant dimension of the origin of the trip.

Figure 1. The last evolution in parking policy: "Origin and Destination Parking System".



1. 1. How to define the parking fee

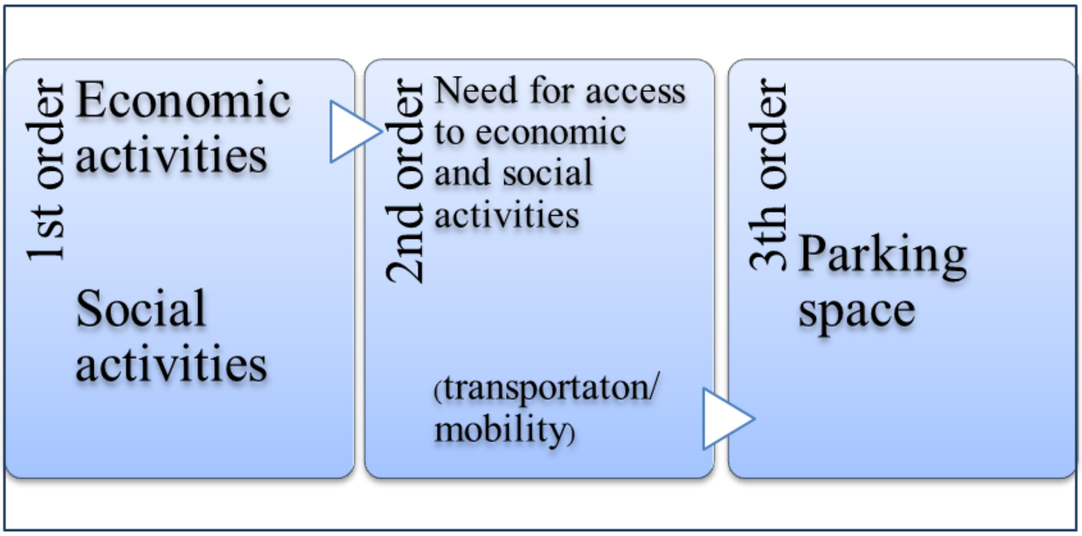
The condition for implementing such a policy is the presence of the main alternative to the car such as a developed public transit system. The cities have to be provided with an underground system, a light-railway, tram and bus (in protected lines) spread within and surrounding the municipality in a reliable infrastructure network. In existence of these characteristics it can be said that we are in an urban context with a valid alternative to the car usage (Verhoef et al, 1995). Even if, it is not enough the existence of the infrastructure, rather it is more relevant its usability. The private car remains the main transport choice in absence of accessibility to the service infrastructure network due to several reasons. Thus, the accessibility, both at the origin and destination per each trip has been defined as the distance to the transport network stop (Fistola, 2009):
High accessibility → the transit station is located within 500 m;
Medium accessibility → the transit station is located between 500 and 1000 m;
Low accessibility → the transit station is located over 1500 m.
Besides, it has not been enough setting the distance to get to the stop, both at the origin and the destination of the trip, but it has been classified also the typology of the infrastructure which defines the accessibility level:

- High accessibility → multimodal exchanger (transit station in which are available two or more transport modes);

- Medium accessibility → bimodal exchanger and park and ride in proximity to the stop;
- Low accessibility → simple stop.

As stated in the previous paragraph, the parking price per hour, within the common framework, has been set by the value of each area, which is influenced by the attractiveness. Therefore, the parking price has been defined by the mobility demand (the parking demand). Indeed, there is not demand for parking without demand for mobility/transportation. In this scheme the mobility is a second-order derived demand consequently to the need for access, which is a derivation from the demand for economic and social activities (Shipper et al., 2000). Therefore, parking is a third-order derived demand directly derived from the demand for mobility (see Figure 2).

Figure 2. Demand of parking as a third-order derived demand



The figure 2 has been considered as the ground plan from which the Origin and Destination Parking System has been built up. Thus, the parking demand increases where the city attractiveness is higher, due to the economic and social activities, as well as the accessibility to various transport modes. The definition of the appropriate parking fee, within the origin and destination parking strategy, has been calculated building a simple matrix: the zones generating the mobility flows have been set in row while the zones attracting the mobility flows in column. All the possible combinations have been generated by crossing rows and columns. Therefore, the whole parking fees range, depending on the accessibility to the origin and destination pattern, has been defined.

Table1. The O/D matrix to define the parking fee

O/D	**Red Zone** High accessibility	**Yellow Zone** dium accessibil	**Green Zone** ow accessibilit
Red Zone (High accessibility)	B.F. + 4 €	B.F. + 2 €	B.F. + 0.5 €
Yellow Zone (Medium accessibility)	B.F. + 2 €	B.F. + 1 €	B.F. + 0.2 €
Green Zone (Low accessibility)	B.F. + 0.5 €	B.F. + 0.2 €	B.F. + 0 €

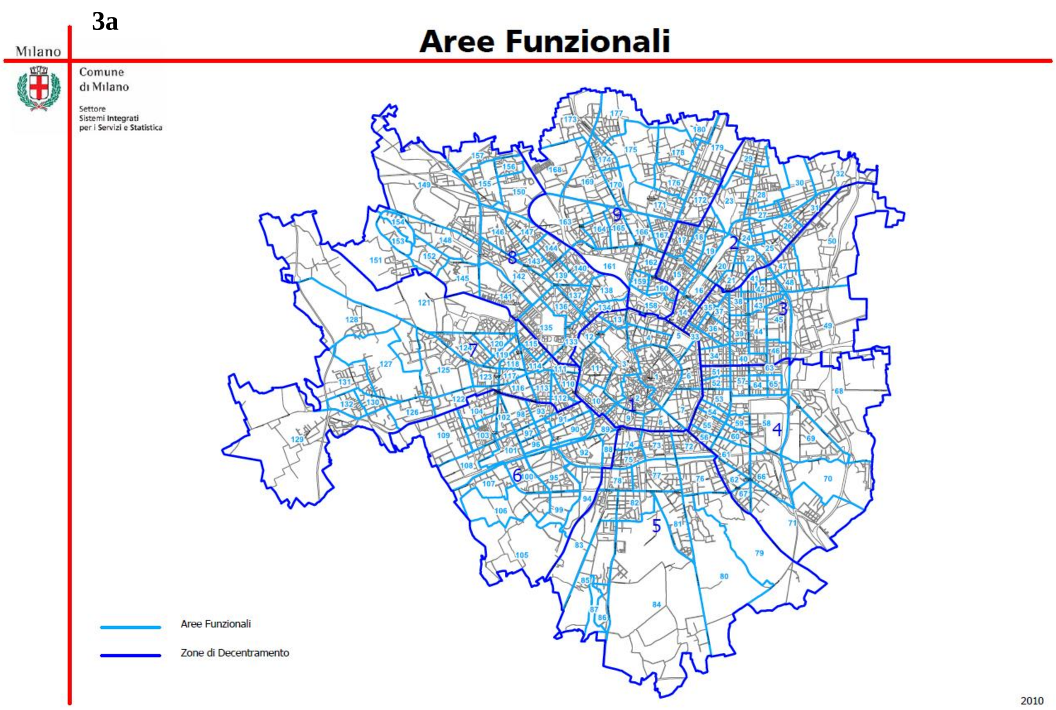
Three different origin and destination zones' typology have been chosen: the red, yellow and green zones. Considering these different typologies, as it has been presented in table 1, and crossing them it has been obtained per each box the appropriate parking value per hour. Therefore, the parking price has been obtained by adding to the basic fee (B.F.), depending on the municipality parking framework, the price obtained by the O/D matrix which depends on the accessibility to the alternatives to the car usage. The highest parking fare has been defined by crossing the red origin zone with the red destination zone (B.F. + 4 euro per hour), while the lowest parking fare has been set by crossing the green origin and destination zones. In this

circumstance the parking space has been given for free, due to the lack of suitable alternatives to the private car. In effect, the attractiveness of these areas is lower than those situated in other areas.

3. Material and methods

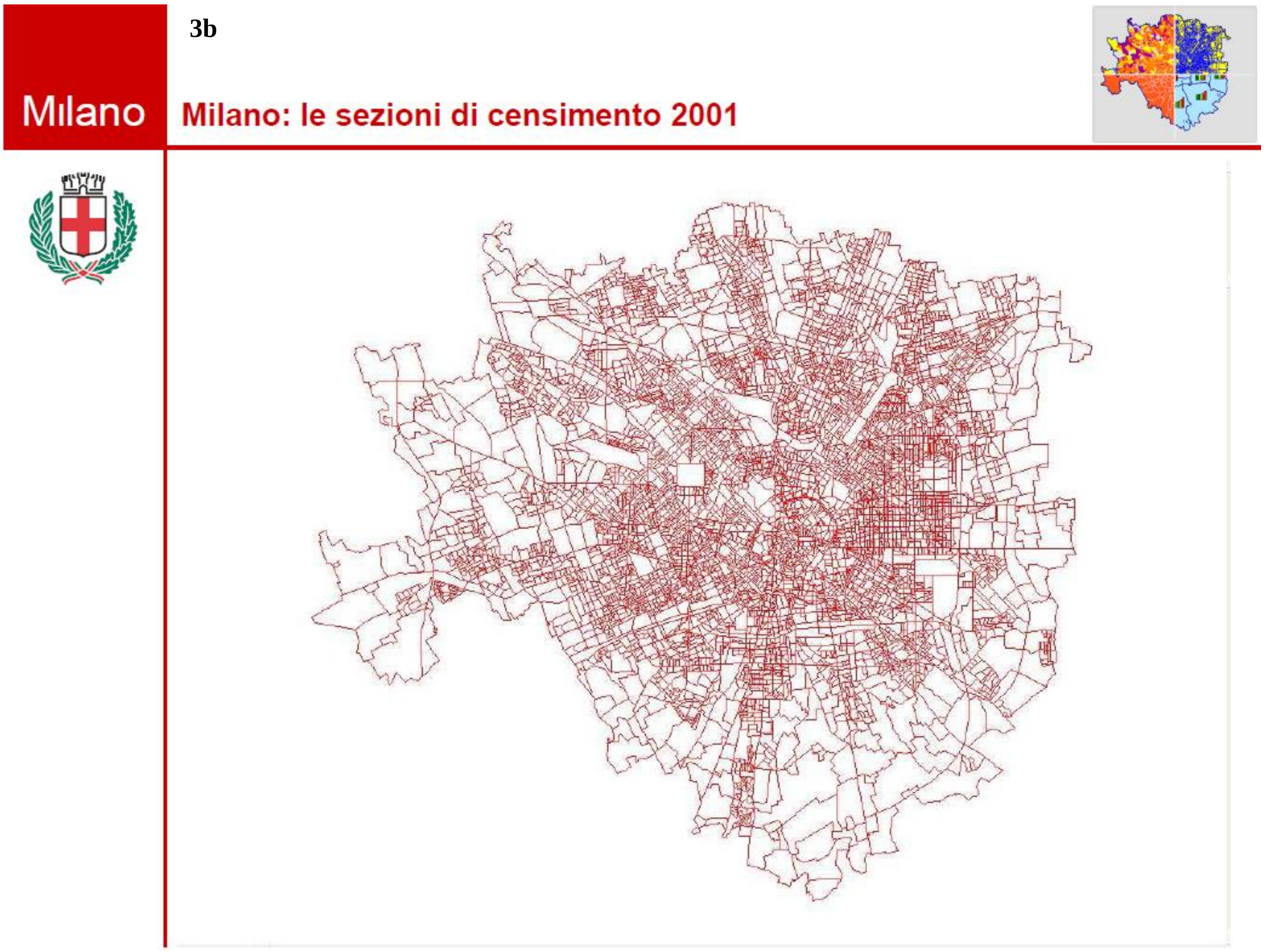
The mobility demand, with particular attention to the parking demand, has been investigated in this project. The city of Milano has been selected as the setting where considering the parking demand pattern and successively mapping the Origin and Destination Parking System. The study could be extended in every location which respects few conditions, as stated above.
This study has been based on the secondary research and the data have been provided by the Italian National Institute of Statistics (ISTAT, 2001). In particular, the data referring to the Population Census in 20012 have been used. The Milano municipality is divided into nine administrative zones, 180 functional areas and 6036 census sections3. Therefore, it has been possible to investigate parking demand within each administrative zone, functional area and census section of the Milano municipality (see figure 3a and 3b).

Figure 3a and 3b. Cartographic representation of the Milano's municipality: 9 administrative zones, 180 functional areas and 6036 census sections.



[2] It is the last census available which provides data per statistical district subdivision. Indeed, the 2011 census returns are not yet available. Moreover, there are no other significant surveys which provide accurate data per the finest statistical-administrative subdivision that are essential for *this* study.
[3] The census section is the smallest administrative area available within the survey and it is comparable to the concept of block.

3b



Source: Milano's municipality (2010).

It has been possible exploring only the commuting trips (working and studying purposes), with Milano as destination area, within the census dataset. All the other trips have been not considered by the census. Without a doubt, it has been a research limit; on the same time it has been taken as an opportunity for studying the systematic mobility which contributes to encourage the long stay parking.
An extensive database has been structured on the origin and destination configuration, per each trip, in which the analysis has been designed. In fact, it has been possible to get the statistic data in order to build an origin and destination matrix. The origin point of the matrix has been expressed by each census section centroid, for the residents in Milano, while it has been indicated the municipality's centroid for the non-residents. The matrix destination point has been expressed by the functional area centroid for the Milano's residents while by the census section centroid for the commuters living out of the city4. Due to the accurate analysis performance ensured by the extension of the above mentioned administrative areas, it has been considered that all the commuters have an equal distribution probability around the origin and destination centroid. Therefore, the centroid measure has been assumed as a really well approximation measure of the exact origin and destination coordinates, due to the lack of other information5. The resulting matrix has been composed by 284.300 origin and destination mobility fluxes with their destination within Milano and which have been characterized by several relevant variables: the number of commuters per each flux (origin - destination) and the transport mode used6.

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[4] It would have been better to dispose all the Milano census sections as destination point, also for the Milano's residents in order to get a more accurate mobility demand representation. The ISTAT does not provide these data. However, the 180 functional areas ensure a really good analysis performance.

[5] The population census does not provide the origin and destination addresses of the commuters. However, the available data allow an accurate analysis performance.

[6] The original dataset gives also several other variables but due to the high number of cases and variables, it has been chosen to select some relevant variables, in relation to the research optimization, for a better data management.

After having classified the opportunity to reach the public infrastructure nodes, and their specific features thus giving an alternative to private car, it has been possible to classify and characterize the municipality zones7. All these procedures can be carrying out in a GIS environment which allows characterizing the entire municipality in different zones per accessibility levels. The whole study has been carried out with the geospatial analysis, to project spatial data extrapolated from Census data, to create geographic information layers, to interpolate point data through the interpolation methodology and to produce thematic maps using ESRI ArcGis. Thus, it has been presented a cartographic representation of the mobility demand first, in order to evaluate the above mentioned parking policy in Milano.

4. Commuting trips in Milano

The daily commuting trips, per working or studying purposes with Milano as final destination, are about one million. About the half of those trips have been accomplished by the Milano's residents while the others mainly by the people living in the Milan metropolitan area (Greater Milan).
The figures below show the rate distribution by transport mode in Milano and among the residents in Milano. The private mobility is the main chosen transport mode (car and motorbike, up to 43% in total and 37% within the Milano residents). The public transport rate is close to the private mobility (39% in total and 33% within the Milano's inhabitants, while the slow mobility (walking and cycling) represents a less attractive transport mode, understandably for those living out of the city (14% and 26% within the Milano's inhabitants). The missing data are both at 4%.

Figure 4a. Commuting trips per transport mode in Milano.

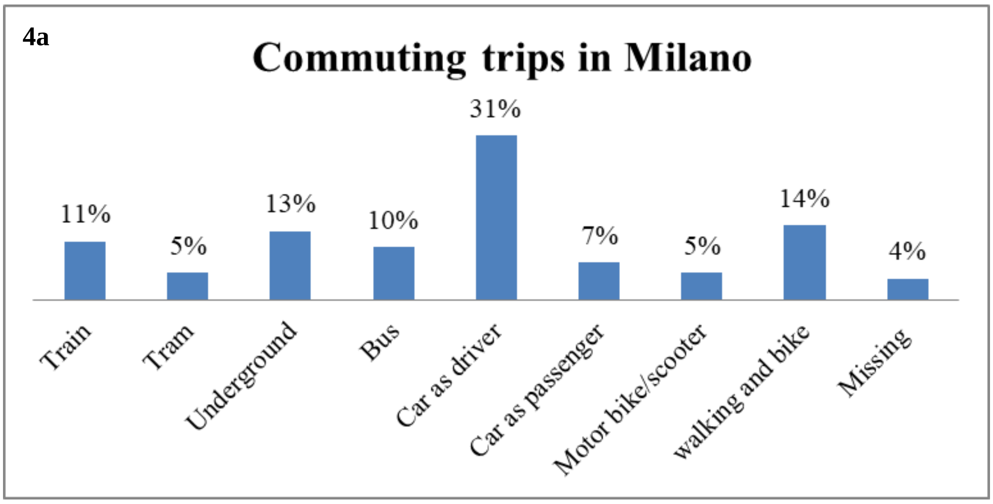
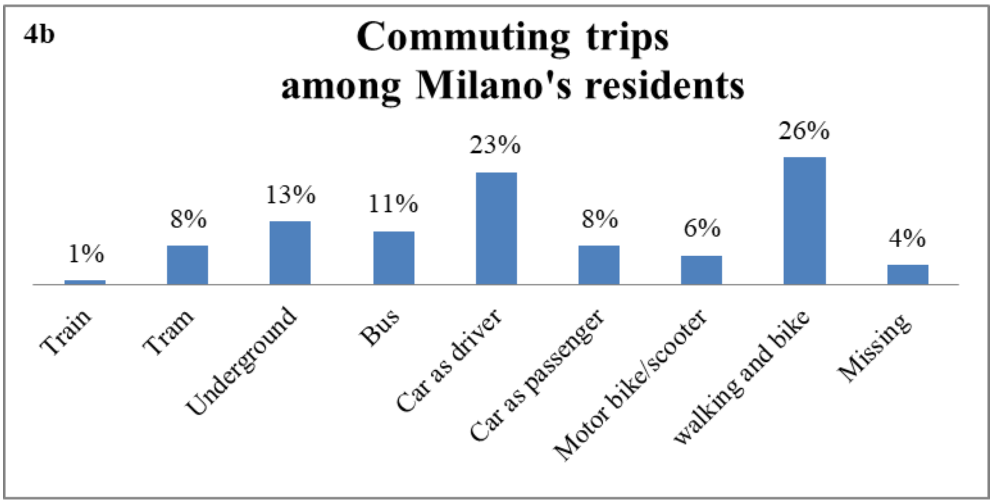


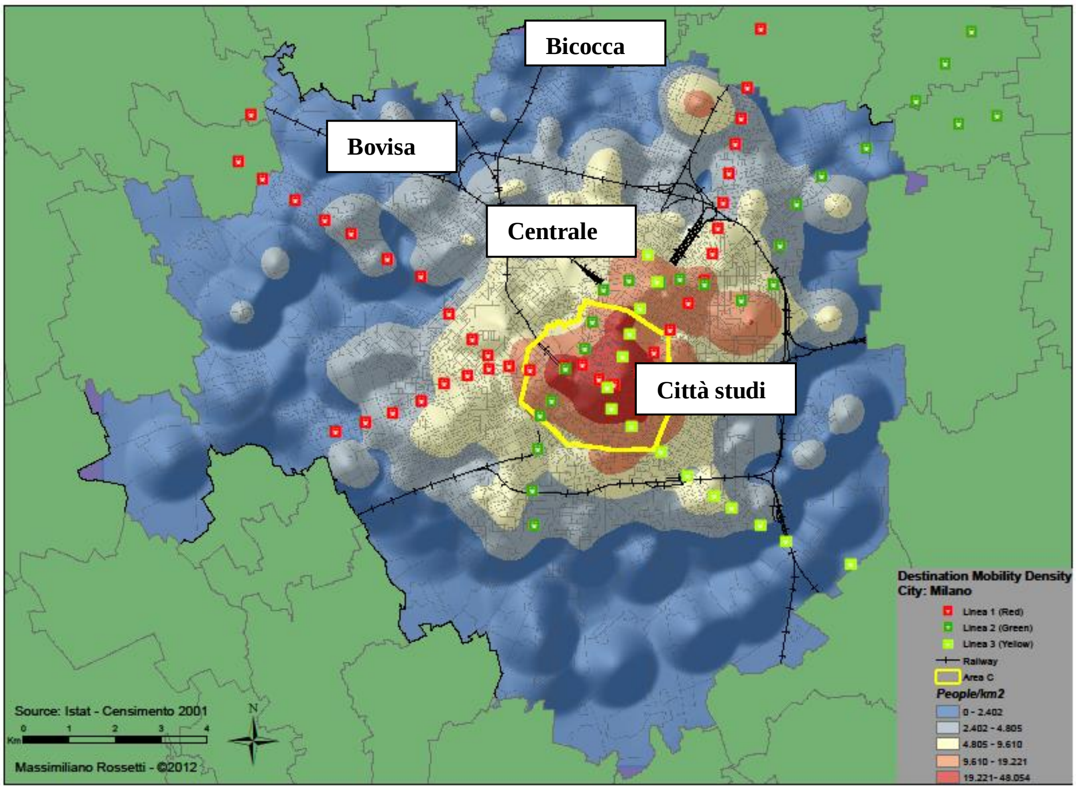
Figure 4b. Commuting trips per transport mode among the Milano's residents.



[7] The census zones, as the more detailed territory subdivision, for instance can be considered as a suitable background in characterizing the district by the accessibility to the alternatives to the car.

The density8 of commuters at the destination zone, independently on the transport mode, has been represented in the next map. A really high density it has been noted in the down – town with a particular concentration around Duomo and San Babila (almost 50.000 people/Km2). Also the Garibaldi and Central station areas show a high concentration of daily arrivals as well as the others two main city attractors: the Bicocca area and Città Studi. It has to be mentioned that at the time of the survey (2001) the Bicocca area was still under a renewal project and the University of Milano – Bicocca has been opened only three years before. Even if several economics, cultural and leisure activities were not opened yet in 2001, that neighbourhood already represented one of the main city attractor, mainly due to the presence of the University. Further research9 has presented the increasing mobility flows which are interesting the area, due to the new opportunities settled in the neighbourhood. Several activities as a new theatre, a big shopping mall with a multi – cinema, banks, companies in the advanced third sector, restaurants, bars and many services mostly related to the university have transformed this former industrial neighbourhood in one of the main crowded place in the town.
Another former industrial localization is the Bovisa area, a semi – centred area located in the north –west part of the town. Even this area since the 1989 has been interested by a regeneration project with the diffusion in the area of few Faculty of the Politecnico di Milano. In 2006 there has been the creation of the Triennale Bovisa (modern art), new offices and television broadcasting, the enlargement of an efficient light railway station and the area is still changing aspect due to the on - going renewal project. Therefore the next population Census (2011) realistically will capture this mutating situation and probably the resulting map could show a red spot in coincidence to the mentioned area.
The other suburb areas, stressed in blue within the map 1, are instead less attractive than the rest of the city. Those parts of the city have not any specific peculiarity which can contribute to attract several numbers of students or workers.

Map 1. Total destination mobility density in Milano.



[8] The classification used in the map legend is the statistic measure of the geometric interval. It has been chosen this statistic classification in order to compare different transport mode density. The starting break value is 5% then 10%, 20% and 40%

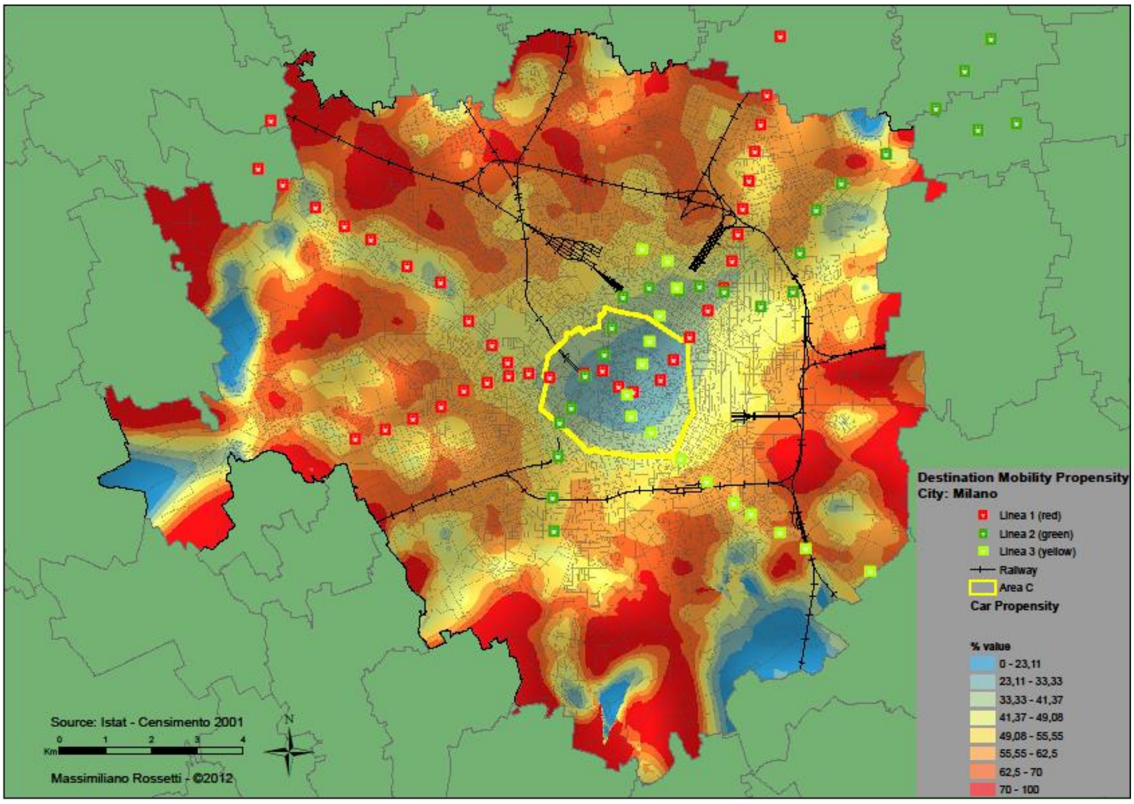
[9] See "Indagine sulla mobilità delle persone" (2005/2006) pubblished by Milano's Municipality, ATM and AMAT.

2. 1. Commuting trips in Milano by car:propensity vs density

The study has been moved in depth towards the evaluation of the propensity of using the car per working and studying purposes in Milano. The resulting outcome gives an answer to the question: which is the inclination towards the transport mode choice in order to reach each final destination? Per each final destination, expressed by functional area or census section, has been computed an appropriate percentage value which represents the tendency to reach the destination by car. It has been tested if the destination zone has any influence on the transport mode choice.

The map below shows a general and distributed high tendency towards the car use. There are city zones, as destination, with a propensity higher than 70%. These areas are mostly located in the suburbs where the accessibility by public transport is less attractive and efficient. Moving towards the inner city the map shows a progressively decreasing trend. The less attractive area for car results the city centre with propensity values between 0 and 23%. Evidently, the car restrictions as pedestrian areas and parking policies in general associated to a better public infrastructure supply discourage the car use. The congestion charge10impact has not been measured by the research because the available data are previous to the introduction of the road pricing scheme in Milano. Further research could be able to evaluate the effect of such policy. In any case, the available statistics confirm a tendency to use the car mainly to reach those destinations located in the suburbs.

Map 2. Destination mobility propensity by car.



Moving to the next map, the car pressure has been represented by the density (user/Km2), which expresses part of the parking demand in Milano.

It has been presented a high density values within the mobility centre (up to 6.600 cars per Km2). The amount of the parked cars can be assumed to be as a long stay parking, due to the purpose (working and studying). Therefore a high amount of those motorists are cruising for parking contributing to create even more congestion. Furthermore, the total amount of motorists is underestimated because it has been calculated

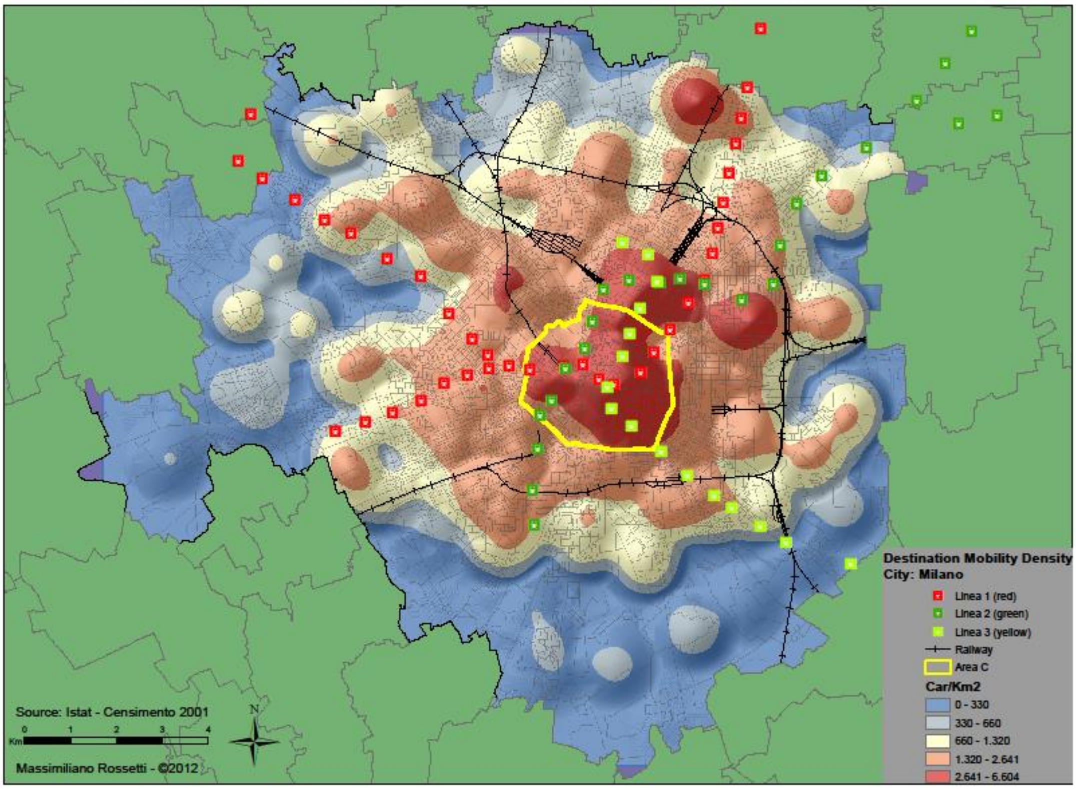
[10] The word congestion charge it has been referred not exclusively to the adoption of the C Area but also improperly to the previous road pricing restriction (Ecopass).

that the trips made for studying and working represents between about 40 and 45% of the whole mobility flow (AMAT, 2007). Therefore, all the other motorists reaching the same area for shopping, leisure and cultural activities contributes to create an even a more congested inner city. The parking policy issue gets in deep with this map and it shows how the nowadays parking policies are not effective. Milano is still a city strongly anchored to the car system since a wide range of population still indicates a car dependency.

In general, the propensity to reach the inner city by car is lower to the rest of the town but in absolute terms the people reaching this area are numerous, due to general pressure towards the inner city, and therefore they are the main cause and result of the city congestion.

This outcome itself would be enough to justify the institution of a congestion charge scheme. Indeed, the data, illustrated in map 3, supports the introduction of the C Area[11], as an economic tool to tackle down the congestion, and underlines the lack of available parking space. Another living matter concerns the extension of the already mentioned C Area. Further an ad hoc analysis has to be carried on towards this topic but a partial conclusion can be anticipated. The map 3 shows a constant high density within the railway ring (to be more accurate this intensity is even larger) and therefore the C area extension would represent the next normal step if the policy makers agree on the congestion reduction. The C area represents about the 6% of the Milano's surface while a hypothetical road pricing enlargement would affect a more wide area. The new underground line of Milano could support policy makers taking this crucial decision in order to improve the whole mobility system.

Map 3. Destination mobility density by car.



5. Mapping the Origin and Destination parking system in Milano

The systematic mobility demand, with particular attention to the car usage, has been presented in the previous paragraph. Therefore, the research has been moved through the simulation on the GIS system of the origin and destination parking policy, as proposed above.

[11] C Area represents a proper measure in order to achieve a specific goal as the congestion reduction. The restriction forms towards few vehicle categories, as Euro 0 engine and others, would reserve further considerations. Indeed, the mobility right get into the discussion when for few motorists is forbidden entering within the C Area. The discussion moves towards the accessibility limitation but it it is not part of the current research.

In the nowadays parking policies all drivers, independently to the origin of their trip, have to pay the same fee, which depends basically on the destination parking location. In order to promote mobility equality and therefore a fairer parking scheme, this research has been designed to consider even the origin and not only the destination in the parking fee calculation.
The motorists, which have Milano as their final destination, have been classified within three categories, according to paragraph 2.1 classification. Only the metro stops12, as the most effective alternative to the car usage, have been considered in this paragraph. A simple stop has been supposed to be the only typology available for the infrastructure network. Therefore, the table 2 shows the drivers distribution within the three categories: within 500 m, between 500 and 1.000 m and over 1.000 m from a metro hub at the origin and destination of their trip for working and studying purpose. The total amount of the motorists is about 300.000. Since the systematic mobility has been considered to be about the 40/45% of the total mobility demand, the everyday motorists in Milano would be at least the double.
The less "sustainable motorists" are collocated in the cell Red-Red zone, the area with a metro stop within 500 m at the origin and at the destination. Those drivers even in presence of a metro hub, a tangible alternative to the private vehicle, really close to their residence and to their work place in any case decide to use the car to reach their destination. The alternative, as the metro transport system has been considered, does not have any effect on their transport modal choice.

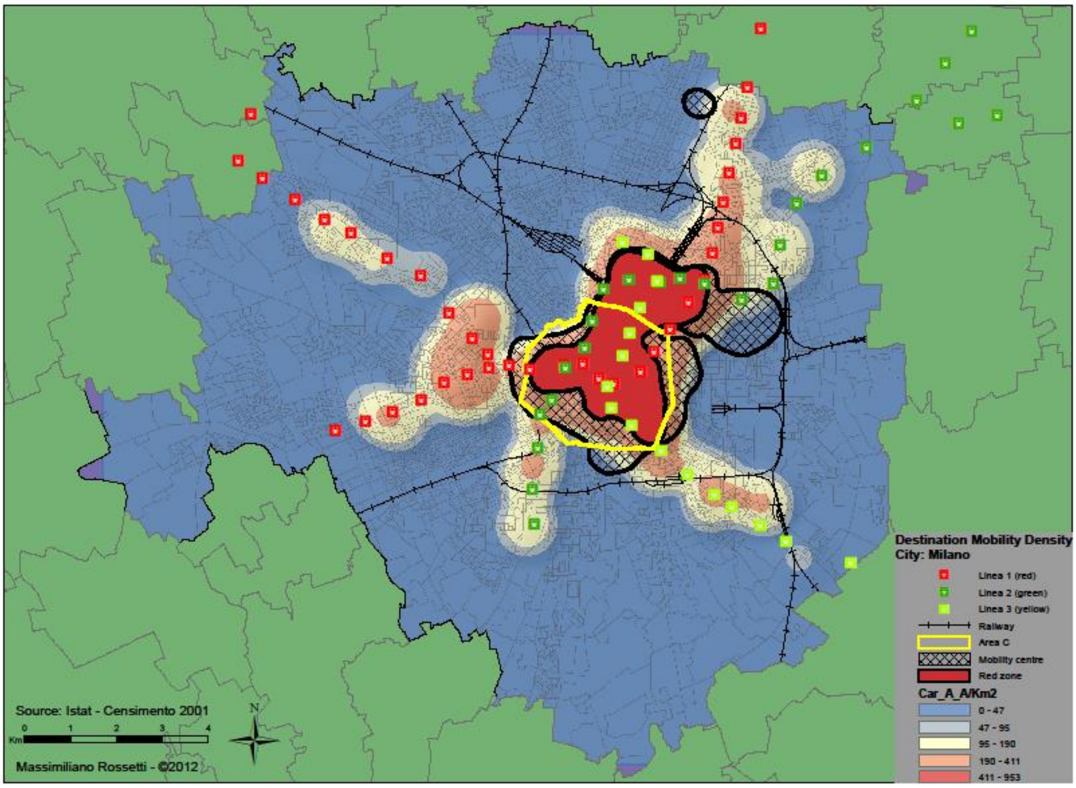
Table 2. O/D parking policy. Drivers distribution within the zones (percentage and absolute values).

O/D	Red Zone	Yellow Zone	Green Zone	Tot
Red Zone	**6% (18.000)**	4% (12.000)	6% (18.000)	**16% (48.000)**
Yellow Zone	7% (21.000)	5% (15.000)	7% (21.000)	**18% (54.000)**
Green Zone	25% (75.000)	15% (45.000)	27% (81.000)	**67% (201.000)**
Tot	**38% (114.000)**	**23% (69.000)**	**39% (117.000)**	**100% (300.000)**

In percentage values these motorists represent the 6% of the whole car drivers, but in absolute terms they represent a consistent amount of commuting trips (18.000) and parking space.
Every day those cars contribute to increase the car pressure within Milano causing the congestion and the lack of parking space in many zones of the Milano city. The next step is to identify where they are distributed in the Milano area. Therefore, the distribution of those motorists has been presented in map 4. The representation of the destination mobility density of those motorists, who have a metro hub within 500 m at the origin and the destination of their trip but still continue to use the car, has been considered. Those drivers are characterized by a systematic attitude toward the car use. It is more a cultural habit and therefore even the presence of a strategic alternative does not affect their modal choice.
The mobility density map has been drawn coherently along to the underground stations, since the other motorists have been deleted from the analysis. The main concentration has been found within the C Area, Garibaldi and Central station13. It has been created an ad hoc zone (the red zone in the map) which indicates the area with a density 14 higher than 400 cars per Km2 up to about 1.000, the highest car density. About 9.500 cars every day park in the red zone contributing to rise up the congestion. This aspect has been reinforced by the presence of the red zone within the highest mobility density area15.

[12]It has been chosen to consider only the metro system in order to obtain an easier network and performing the simulation with a more clear understanding. Further analysis would consider the whole transport system and other variables in order to achieve a more effective parking policy.
[13] The area with the highest mobility density, as presented in the previous paragraph.
[14] Destination mobility density for drivers with a metro hub within 500 m at the origin and destination of their trip.
[15] The highest mobility density area has been stressed by the black net.

Map 4. Destination mobility density for those car users which have a metro stop within 500 m at the Origin and Destination of their trip (the "Red zone" within the higher mobility density)



3. 1. The application of the parking policy

An equal parking policy, as the one proposed in this research, would move towards the implementation of a differentiated parking fee depending also on the origin and not just on the destination, as presented in table 1. Forgetting for a while the actual parking framework adopted by the city and therefore the basic fee, the implementation of such policy would affect, with the highest parking fee, those drivers with the highest accessibility to the underground stop both at the origin and destination. Gradually, the parking fare decreases at the half, ¼ and till € 0 in presence of the lowest accessibility to the metro hub at the origin and destination per each trip.

Thus, it has been presented a selective parking fee which does not bear down on all drivers but on those considered less sustainable, due to the alternative to the car usage. Furthermore, this parking policy would reinforce the municipality financial resources in order to invest in sustainable mobility (see table 3). Therefore, given the drivers distribution by the O/D parking scheme has been feasible computing the estimated revenue per hour according to the parking fee exposed above. The contribution of those driving from a red zone to a red zone (6% of the drivers) would be higher than those distributed on the other cells. Thus, the 6% of the Milano's drivers would generate the 34% of the parking revenues per hours. Otherwise, those drivers would reconsider their mobility strategy, due to the changed parking scheme, towards a less expensive and sustainable modal choice set along their mobility pattern.

Table 3. "Origin and Destination Estimated Parking Revenue per hour".

O/D Estimeted Revenue per hour	Red Zone	Yellow Zone	Green Zone	Tot
Red Zone	€ 72.000 (34%)	€ 24.000 (11%)	€ 9.000 -4%	€ 105.000 (49%)
Yellow Zone	€ 42.000 (20%)	€ 15.000 (7%)	€ 4.200 -2%	€ 61.200 (29%)
Green Zone	€ 37.500 (18%)	€ 9.000 -4%	€ (0%)	€ 46.500 (22%)
Tot	€ 151.500 (71%)	€ 48.000 (23%)	€ 13.200 (6%)	**€ 212.700 (100%)**

6. Conclusion

The car is the most significant transport mode which triggers to the congestion, as it has been stated during the last century (Sheller at al., 2000; Urry, 2004). The reduction of the other externalities, involved in the car system, is possible by reducing the congestion. The line of thinking is based on this general and simple assumption. There is a need to shift the attention on the way to tackle down the congestion, avoiding creating more parking spaces which contribute to generate more congestion, by promoting mobility policies (demand oriented) able to reduce the car attractiveness and dependency (Urry, 2009). Thus, mobility policies able to scratch the mobility behaviour without reducing the accessibility are needed (Colleoni, 2008).

Since the parking demand remains at a high level, as it has been presented in maps 3 and 4, the nowadays parking policies are not effective. Milano is still a city strongly anchored to the car system since a wide range of the population still indicates a car dependency. In general, the propensity to reach the inner city is lower than the rest of the town but in absolute terms the people reaching this area are numerous, due to general pressure towards the inner city, and therefore they are the result and on the same time the main cause of the city congestion.

Further research in Milano could be conducted in parallel on parking policy and congestion charge as complementary economic tools to manage the mobility demand. In any case it seems to be out of any doubt that the origin and destination parking system presents numerous advantages in terms of equity and discouragement of the car use for those motorists which have high accessibility to a feasible and efficient alternative to the private car. On the contrary, the revenue coming out from the implementation of the policy could be constrained to promote a more sustainable transport system in order to improve the whole city system.

Furthermore, a more sophisticated model, which could take into account other criteria to define the accessibility, as for instance the distance to the whole public transport network supply (giving a parameter per each mode), the trip length, the age of the motorist and/or health condition, the weather conditions etc., is crucial in order to develop a new knowledge around this subject. The ambitious project is to develop a further step on parking policy which can be included in the evolutionary pattern as showed above. A new approach which could regulate the future parking spaces in our cities and therefore it could reduce the congestion within the urban areas. The idea under this project has been to bring into being the development of an extensive knowledge on parking and its evolution. The policy implementation, after an improvement stage, could be test in those cities, as Milano, affected by congestion where a developed transit network is available. In particular, the policy could be implemented first as mobility management strategy within companies. In this case the destination is fixed while only the origin is a variable field and therefore the parking calculation becomes easier and manageable.

In general, there are several interesting considerations under the maps representation, but the most important is the exhibition of a different approach to the mobility studies within a GIS simulation. The potential impact of the demand oriented method in urban mobility planning it has been historically underestimated, at least in Italy, but new challenges concerning the accessibility, the land use and the mobility demand have to be taken into consideration.

7. References

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