CONNECTIONS BETWEEN MOBILITY AND URBAN FABRICS IN THE CITY OF BURGOS (SPAIN)

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RESUMEN

Previous research has studied possible links between different urban environments and induced mobility. The traditional Spanish city patterns have specific features that promote the use of soft modes, mainly favouring pedestrian presence in the streets. Nevertheless the last twenty years development has changed the previous urban reality in many towns, following some sprawl characteristics and occupying much more land than strictly necessary. Accordingly, we have analyzed the morphology of Burgos using the perspective of urban fabric differences. Focusing in some parameters such as density of dwellings, population and compactness, we have tried to understand the underlying correlation between urban environment and private car trip generation.

However, although some of these urban variables can be considered as quantitative and quick indicators for unsustainable modes of transport, the effects of compact or diffuse development cannot be figured without taking into consideration other parallel factors that configure urban vitality. A previous qualitative analysis of urban growth and development may help to grasp this reality, connected with design criteria trends and urban planning policies. Likewise, mobility cannot be completely understood if only quantitative correlation is prosecuted. The retail distribution or concentration, the presence of malls, the excessive streets broadness, the existence and size of open spaces, or the residential building typologies have verifiable impact on the final modal share. Our results show clear correspondence between low dense urban fabrics and higher number of car trips. Hence, future urban development and reform policies must be oriented if sustainable mobility objectives want to be fulfilled. We suggest some final recommendations with this aim.

1. INTRODUCTION

Multiple studies have tried to understand the underlying connection between urban morphology features and mobility, many of them trying to find the best practices to achieve sustainable solutions and policies. Research has used different statistical and modelling tools and approaches to tackle this. An important part of the results have shown that compactness and density are initial indicators of a lower use of car in terms of kilometres travelled (Ewing et al., 2018; De Vos, 2015; Ewing and Cervero, 2010).

However, some others have evinced no significant influence, no direct effect reflected in the analysis, or an increased complexity due to regional differences (Maat et al., 2005; M. G. Boarnet and Sarmiento, 1998; Ewing et al., 1996; M. Boarnet and Crane, 2001; Lin and Yang, 2009). Anyway, we can accept an academic consensus about the convenience of the so called 5D-variables explained by Ewing and Cervero (2010) in terms of sustainable urban development: density, diversity, design, distance to transit, and destination accessibility.

Critically reviewed, we can argue that in many of previously referenced works there is a strictly statistic use of data. Neighbourhoods, districts, towns, suburban areas, travelled kilometres, shopping areas, citizens, and number of trips are numerically adopted by a more simple or complex model to study the possible correlations. Nevertheless, spatial differences are usually forgotten, even when important variances can be observed in very near zones or neighbours. We find here a gap in this kind of studies that must be accordingly revised and which plays a special role in small and medium cities (SMCs) due to the reduced trip distances.

Moreover, density and compactness cannot be analyzed as isolated variables. Counterbalance effects were identified in large cities when high congestion may be provoked by origin-destination concentration, where increased investment on highways is consequently required (Ewing et al., 2018). A carefully design of land use distribution added to parking control measures were identified as requirements to reduce car dependence, seeking for polycentric distributions and adequate mix of uses (Choi, 2018).

On the other hand, low density and compactness have been previously identified as key factors in many other negative factors: health problems (Hamidi et al., 2018); local urban service and facilities costs (Sole-Olle and Hortas-Rico, 2008); and ecological or pollution drawbacks (Cárdenas Rodríguez et al., 2016; Chen et al., 2019). The important impact that transport and urban planning policies has on climate change mitigation strategies has been also recognized by the Intergovernmental Panel on Climate Change (Sims et al., 2014), which suggested a reduction in private cars use as a major contribution to achieve these objectives.

In summary, research has shown the potential of urban planning decisions on mobility, and their implication on health and other important issues. However, we consider that the particular urban morphology of each city plays an essential role in the understanding of this connections and possible effects. Therefore, we introduce here a novel path to perform a locally oriented study of theses links, as an alternative o complement to mere statistical or numerical approaches that forget the city singularities. For this aim, we suggest an urban pattern and tissue analysis to find out possible expected differences when similar values of density or compactness are compared.

2. URBAN TISSUES ANALYSIS

For the purpose of this work, we have selected the city of Burgos as an example of Spanish SMC. Due to its population of 175821 inhabitants (Spanish Statistical Office, 2019) we can consider it as a representative MC according to European statistics. Burgos, placed in the north of Spain between Madrid and Bilbao, experienced a quick increase in number of inhabitants between 1996 and 2012, and after a slight reduction is now in a plateau situation (fig. 1). Burgos has an important heritage ensemble and is crossed by Arlanzón River in the east-west axis. Current local land-use regulation was planned in 2008 and reviewed in 2013, including a set of developable zones denoted as sectors by regional laws.

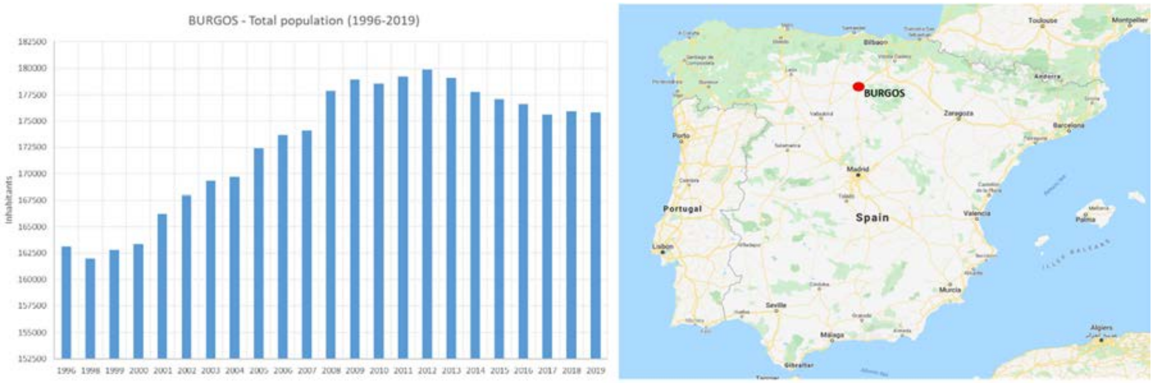

Fig. 1 – Population and location of Burgos (Spain). Source: Google Maps

Fig. 2 – A selection examples for the different urban tissues identified in the city of Burgos. A: historic centre; b: the garden city concept; c: traditional popular area (type 1); d: traditional popular area (type 2); e: first extension; f: second extension, compact; g: second extension, ultra-compact; h: second extension, open type; i: third extension. Source: Google Maps.

Regarding to the already built land, the growth of the city has experienced different phases. This growing mode is very linked with the urban tissue distribution and contrasts. In fact, we can distinguish the following fabrics in parallel to the historical spread of the residential uses. We here generally agree with previous selection criteria by other authors (Andrés López, 2013), but grouping part of them in homogenous sets: Historic centre and near surroundings, Garden city, Traditional popular areas, First extension (1930-1964), Second extension (1960-1980), Third extension (1980-nowadays). Performing a brief analysis of planning features of each of them is an unavoidable step to understand the daily movements of neighbours.

2.1 Historic centre and near surroundings

Although the city was founded around 884 A.D., many buildings in this area were erected between the endings of 19^{th} century and the fifties of 20^{th} century (Andrés López, 2004), and an important part of them have been internally refurbished or adapted in the near past (Fig. 2a). However, the singularities of this district and tissue are intrinsically connected to its origin: a medieval urban pattern with narrow and irregular streets, very compact small-buildings distribution, outdated services, and lack of parking lots. Burgos centre is, since many years ago, partially pedestrian. Nowadays the district is focused on tertiary sector, attracting a vast part of city population to its restaurants and bars, and very connected to the tourism due to the heritage richness.

2.2 Garden city

This special tissue is not a follower of the original Garden City movement spirit, but nearer from the Garden Suburb concept (Andrés López, 2000). Like in other Spanish cities, mainly during the twenties of 20th century, the emergent bourgeoisie was offered to live in specially designed areas for high-income families. These types were commonly placed in the periphery, and the use of vegetation played an important role in the concept. Initially disconnected from the urban core and designed with very low density of detached single-family houses, the growth of Burgos has engulfed this neighbourhood (Fig. 2b).

2.3 Traditional popular areas

Inside this tissue we want to distinguish two different types or groups of popular areas. The first (type 1 in Fig. 2c) are related with the so called Low-income houses law (*Ley de casas baratas*), which were built in Burgos during different phases between 1911 and 1936 (Delgado Viñas, 1992). The main characteristic is the typology: semi-detached or attached single-family houses, with small gross floor area, a little garden included, and reduced budget. Most of these have been already demolished to build multifamily buildings during the 20^{th} century. However, some of them continue in the same position and configuration, although many have been refurbished to be adapted to current building and isolation standards.

The second group (type 2 in Fig. 2d) consists of three low density small popular neighbourhoods built around the thirties of 20th century. Generally speaking they have with very similar features than the first group, but the number of houses is bigger forming each one a sort of core, like a very small village. The size of dwellings is usually bigger in this case. Even though they were initially built far away from urban core, the growth of the city has reached them.

2.4 First extension (1930-1964)

A reduced residential multifamily development was produced during the post Civil War period. The closed block is the used typology (Fig. 2e), with a very compact distribution of dwellings and relatively high population density. A not fully regular gridiron plan was used for the street pattern. Commerce is placed in the ground level.

2.5 Second extension (1960-1980)

An important growth occurred in this period, affecting to several zones of the city. We can distinguish here differences depending on the year of design. First, a compact (Fig. 2f) or ultra-compact (Fig. 2g) closed block solution was extensively used, reaching an exceptionally high population density. Here a lack of parking lots and open spaces is often found, but the compactness promote on foot daily trips. On the other hand, open types like blocks and towers were built (Fig. 2h), with open spaces or parking areas around them.

Sometimes the buildings are distanced each other, extending pedestrian distance. This tissue was also affected by the intersection of big mono-functional zones (mainly sports and schools). Although buildings by itself are densely populated, the distances and interspaces reduce global values for this variable. The ground floor includes space for tertiary sector.

2.6 Third extension (1980-nowadays)

The latest developments are usually featured by oversized carriageways, commonly using a grid pattern (Fig. 2i). Regarding to typologies, a mix of possibilities is found. The open block is revisited, and the closed block has been erected sometimes with a bigger horizontal dimension. Internal block areas include occasionally private services (sport yards, green zones, swimming pools…). Open spaces are often underused due to size, design or placement. Although a mix of used is promoted by regulations, it is usually formalized using detached buildings, while ground floors are sometimes devoted to residential uses. In some cases the planned density has been not reached due to incomplete development, or the presence of half-empty buildings.

2.7 Tissues summary

Table 1 qualitatively summarizes the basic characteristics of Burgos urban tissues.

	Tissue	Density	Open spaces	Commerce
a	Historic centre	M	M	H
b	Garden city	VL	L	VL
c	Traditional popular area (type 1)	L	VL	VL
d	Traditional popular area (type 2)	L	L	VL
e	First extension	M - H	L	H – VH
f	Second extension (compact)	H	L – M	H - VH
g	Second extension (ultra-compact)	H -VH	L – VL	VH
h	Second extension (open type)	M - H	H – VH	L- M
i	Third extension	M	M - H	L - M

Table 1 – Tissues features as a glance (VL= Very Low, L=Low; M=Medium; H=High; VH= Very High).

3. URBAN PARAMETERS AND GENERATED CAR MOBILITY

The use of official statistics and cadastral data for population and dwellings (Spanish Statistical Office, 2011; Spanish Cadastral Office, 2017) was combined with a GIS software (QGIS Development Team, 2017). To compute density and compactness, postal sections were used as geographical divisions. Population was randomly placed in each section. To calculate compactness, a total buildings volume estimation was divided by section area. OpenStreetMap database (OpenStreetMap, 2019) was consulted to gather the distribution of common commercial uses: small shops and offices, cafeterias, bars, retail business, bank offices…. Number of private car trips generated were also extracted from the origin/destination matrix from a mobility study included in the city General Plan (Burgos City Hall, 2014), which were later coherently and randomly dumped in the already mentioned sections. Different maps were performed as layers using QGIS tools as a result of these operations (Fig. 3), generating heat maps for population density, commerce and trips. Number of trips was normalized using population and areas of each section for comparison purposes.

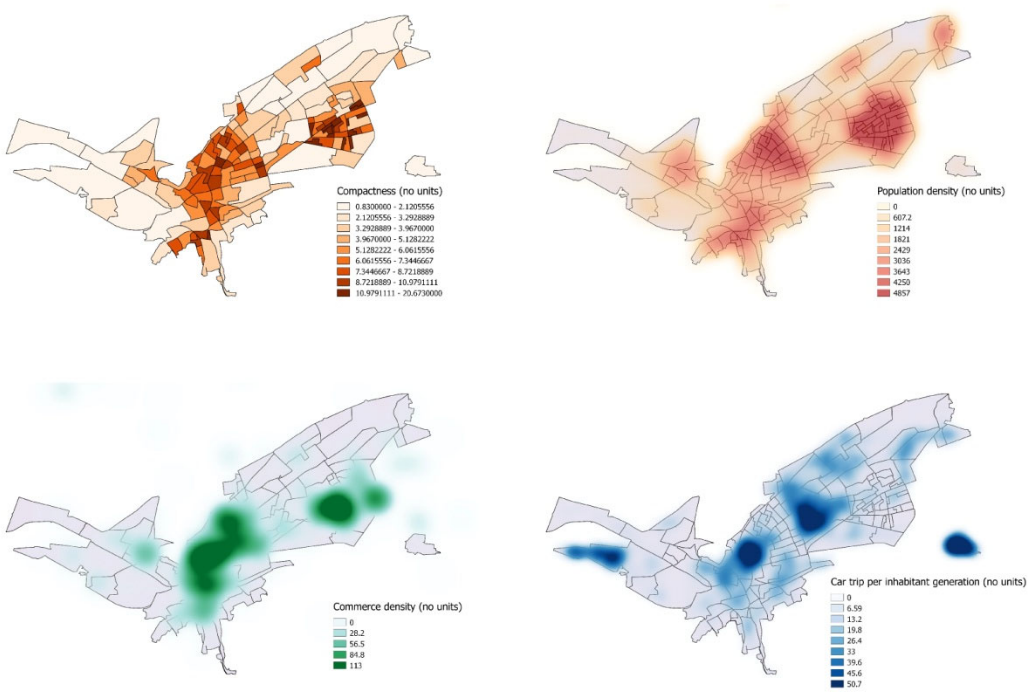

Fig. 3 – Top left: compactness density. Top right: population density. Down left: commerce density. Down right: generated private car trips density. In all cases, densities have no units but represent clearly the differences among the different sections.

As a result, a noticeable correlation can be identified between compactness and density, and also with the retail business distribution pattern. Regarding to mobility, zones with lower commerce presence are those with a higher generation of car trips. Moreover, the features of the urban tissues (Table 1) and the position on the city map are very connected with the generation of private car trips. The mentioned features have to be joined with some other section variables as the age of population and number of young families. Fig. 4 includes the map of the city and car trips, superimposing the characteristic tissue of each part of the city.

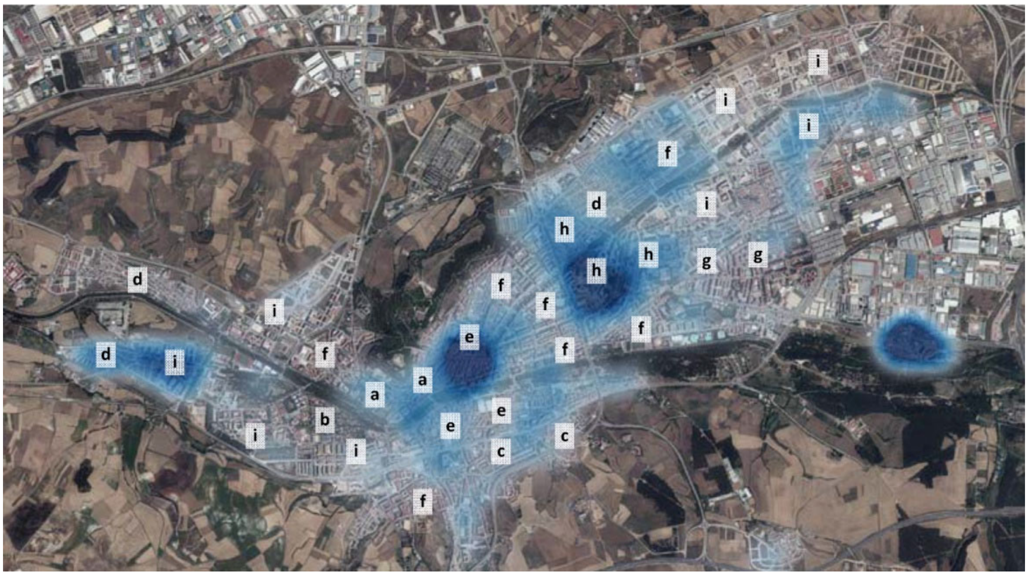

Fig. 4 – Density of generated car trips over the tissue map distribution.

4. PLANNING RECOMMENDATIONS

The links between urban environment characteristics and mobility shown by our results allow inferring a set of recommendations for future planning decisions in SMCs development:

- Regulation may be not enough to achieve sustainable mobility results if not clear objectives are prosecuted and implemented For instance, a minimum mix of uses can be applied in a development area without avoiding segregation of commerce.
- To obtain adequate results in diversity of uses, a minimum density of 80-90 dwellings per hectare may be considered as the standard.
- Although important, high density is not enough to reach adequate values of compactness and variety in the area where are placed. Additional requirements must be applied in addition to mere density, because it can be distorted by the use of high density buildings (e.g., tall towers) in a low density area. However, density may be a good indicator when compactness and short distance mix of uses are fulfilled.
- Number and position of parking lots must be strictly studied to avoid attraction of unnecessary car trips.
- Pedestrian friendly environments, and short trip distances by adequate mix of uses are adequate policies to promote. Open spaces are needed and coherent with these principles, but the size and position must be carefully designed in a bigger scale. Too big open spaces may become counter-productive, underused or empty islands, increasing also pedestrian distances.

4. CONCLUSIONS

Previous research has applied statistical models to huge databases in large metropolises or urban regions.

We have oriented our work to a visual mapping and comparison in a particular city reality, to identify local particularities in its daily trip context. Our study has shown not negligible links between urban planning decisions (i.e. urban tissues) and induced unsustainable mobility in a SMC. Therefore, we suggest a set of recommendations to promote active travel modes and reduce car dependence.

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