2020/01/13. *Word count: 2.908*

What pre-existing characteristics may help define the future public spaces in the Eixample superblocks?

1. Introduction

The city of Barcelona is frequently considered as a paradigm of urban efficiency. This is largely due to the design of one of its largest districts, the Eixample. The abstract grid of blocks designed by Ildefons Cerdà in 1860 has been able to mutate according to the urban demands of more than a century of history, combining a high population density with an efficient distribution of services for citizens.

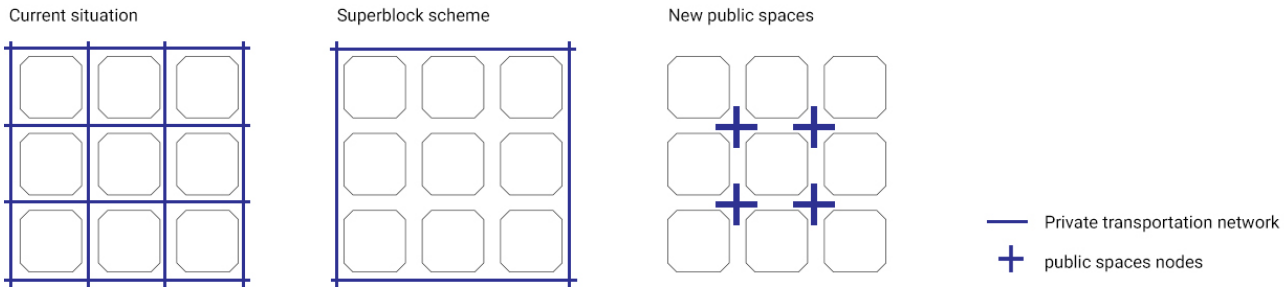
In spite of its uniform design, the buildings that conform the traditional Eixample block, as well as its uses and its (reduced) public space, are highly heterogeneous. The same grid gives rise to the most luxurious shopping street in Barcelona, to densely populated areas with little commercial presence and primarily industrial areas without any kind of night-time activity.

Although indisputably virtuous, the Eixample also has serious deficiencies, mainly in relation to the lack of urban green, public space, noise and pollution caused by the significant volume of traffic that its streets suffer.

In recent years, these problems have led to the design of a new master plan covering the entire urban area of the city: the superblocks. The superblock model is based on the grouping of blocks that make up the city, inverting the distribution of public space between private traffic and citizens (Àrea d'Ecologia Urbanisme i Mobilitat 2016). This model is especially logical in the grid of the Eixample, where rationality makes the superblocks an logical evolution of the traditional Cerdà block.

The ultimate goal of the plan is to improve the life of the city's inhabitants. With this precept, it largely limits private mobility with the aim of improving air quality and offering new public spaces to pedestrians who until now were occupied by cars. In the case of the Eixample, these new spaces will materialize in the road intersections inside the superblock (Figure 1).

Figure 1. Key structure of the superblock and new public spaces



The strategy followed so far by the administration has been the gradual implementation of new superblocks and the application of "tactical" urban planning to the spaces recovered for the citizens. This urban planning is

based on the use of non-permanent structures such as playgrounds, rest areas and mobile vegetation. At the same time, these projects have been agreed with the neighbours through extensive processes of citizen participation to avoid a top-down design approach.

The results of these public spaces in the area of the Eixample have so far been mixed. The superblock of Poblenou, one of the first to be created, was the cause of controversy between the residents and the administration, even leading to the creation of citizens' platforms to demand its elimination, alleging the desertification of public space for much of the day. On the contrary, the most recent superblock in Sant Antoni has functioned as a space for meeting and socialising since the first day, offering the residents new opportunities for interaction and recovering a small portion of Eixample for the citizens (Figure 2).

Figure 2. Poblenou and Sant Antoni public spaces in the superblocks

Source: Constraula (constraula.com) and Betevé (beteve.cat)

Both experiences are based on the same principles of urban design and had participatory design processes. Even so, the pre-existing particularities of the built environment are fundamental when it comes to designing public spaces that have to be used and appropriated by the citizenry, as recognised in the city council's action plan itself.

In this sense, the global vision of the existing services, businesses and urban qualities of the fabric that makes up the city becomes essential to determine possible future uses for these new public spaces. A large-scale strategy can provide the general guidelines for action that will enable public space projects to be developed within a global framework.

2. Research question

What pre-existing characteristics may help define the future public spaces in the Eixample superblocks?

This question focuses on identifying the urban qualities of the Eixample as a system for detecting opportunities for the future public spaces of the superblocks. The objectives of this research project are:

- To prevent areas where public space will have a lack of vitality.
- To take advantage of existing facilities nearby that can have a relation with the new public space activity, avoiding the repetition of generic designs without a specific use.

3. Literature Review

The Eixample of Barcelona is surely one of the most studied and documented urban plans in history. The project itself is detailed in the "General Theory of Urbanization" (Cerdà 1867). In it, the construction of cities adapted to transport and new hygienic conditions is proposed (Magrinyà 2008).

Its reticular structure has made it especially attractive for studies where mathematical and physical theory are combined with the urban aspects of the city (Greenacre 2002; Casellas and Pallares-Barbera 2009). Likewise, from an architectural point of view, the building typologies and its urban qualities have also been the subject of numerous academic works (Castiñeira Palou *et al.* 2014).

The project of the superblocks is part of the “Pla de Mobilitat Urbana” of the Barcelona City Council (Ajuntament de Barcelona 2015). It proposes the change of model towards a city where the circulation with the private vehicle is going to be restricted with the objective of improving the pollution and recovering free spaces for the citizens. This last wish is included in the document "Omplim de vida els Carrers” (Àrea d’Ecologia Urbanisme i Mobilitat 2016), where the general lines of occupation of the public space of the superblocks are indicated.

This brief research project aims to contribute to define future activities in the public space of the Eixample superblocks, following the trail of projects such as the Ciutat Vella district use plan (Santamaria Varas and Martínez Diez 2018). In this sense, activity will be defined as the sum of vitality and diversity (Montgomery 1998), a combination of factors that can be studied through the indicators detailed in the methodology.

The concept of vitality is understood as the capacity of a place to promote social interactions and economic activities (Jacobs 1961). A common resource in urban research papers is to assimilate vitality to the density of small business in the area (Joosten and Van Nes 2005; Zukin 2010; Ye *et al.* 2018).

In addition to the concept of vitality, the research project considers pre-existing facilities close to the studied spaces as a catalyser of the cultural and social activities that must take place in a public space (Montgomery 1998).

4. Methodology

Code for both QGIS and R procedures is described and available at https://github.com/aac190/superblock/

The methodology for this research project is based in the published paper “Creating a Geodemographic Classification Using K-means Clustering in R” (Lansley and Cheshire 2018).

The use of K-means clustering aims to classify each superblock public space according to the different characteristics of its surrounding environment. In order to perform the analysis, each public space is represented as a node in the intersection between the two streets that define it.

The first group of variables considered are Sqm of Residential surface and Number of small businesses around the node. These two sets of data aim to identify those public spaces that have a substantial number of people living around them and/or a high number of small businesses, considered as an indicator of vitality.

The second group of variables represent diverse private and public facilities present in the city. Each one of them has qualities that can potentiate an activity in the nearby public space.

Applying K-means clustering to this set of variables can offer a first approach on how to think about these future public spaces’ activity.

4.1 Data sources

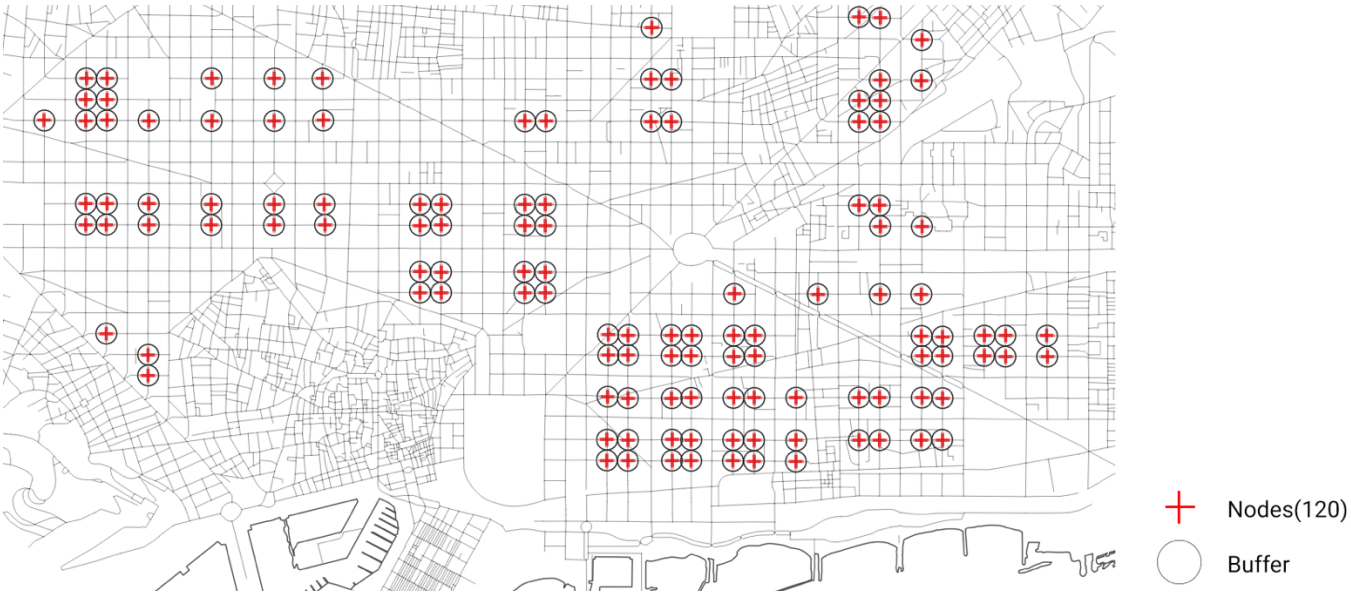
- Superblock nodes extracted from the road system shapefile for Barcelona[1] and selected accordingly the 120 potential road-crossing from the "Pla de Mobilitat Urbana" (Ajuntament de Barcelona 2015)
- Residential surface from the Spanish Cadastre "Inspire"[2] shapefile.
- Local businesses (as a vitality proxy) from the Barcelona Open Data portal[3]. Selected those under the "Small commerce" category that are unique to avoid large commercial operators following the same principle as previous research papers (Joosten *et al.* 2005; Zukin 2010; Ye *et al.* 2018).
- Restaurants from the Barcelona Open Data portal[4].
- Cultural facilities from the Barcelona Open Data portal[5].
- Schools and education facilities from the Barcelona Open Data portal[6].
- Retirement homes from the Barcelona Open Data portal[7].

4.2 Aggregated dataset creation

All the selected data is aggregated in a single dataset containing the Superblock nodes as point information and the count of facilities for each indicator in proximity with each node.

In order to achieve that, a buffer of 66.65m is applied to the Superblock nodes (Figure 3) responding to the average measure of the Eixample block and the surrounding streets (Figure 4).

Figure 3. Superblock nodes and corresponding buffer



[1] https://w20.bcn.cat/cartobcn/

[2] http://www.catastro.minhap.es/webinspire/index.html

[3] https://opendata-ajuntament.barcelona.cat/data/ca/dataset/cens-activitats-comercials

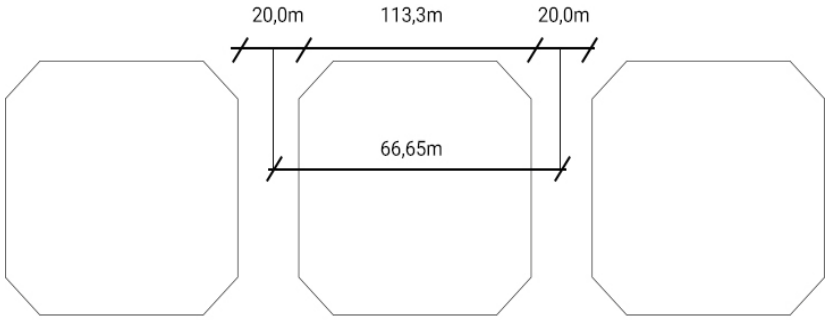
[4] https://opendata-ajuntament.barcelona.cat/data/ca/dataset/cens-activitats-comercials

[5] https://opendata-ajuntament.barcelona.cat/data/ca/dataset/equipaments-culturals-icub

[6] https://opendata-ajuntament.barcelona.cat/data/ca/dataset/educacio-ensenyament-reglat

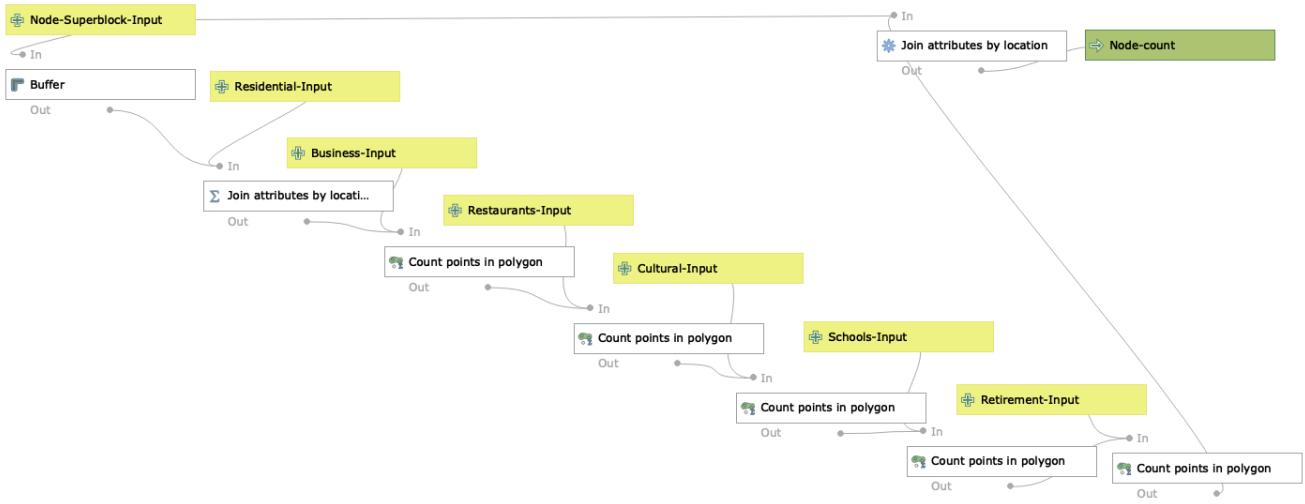
[7] https://opendata-ajuntament.barcelona.cat/data/ca/dataset/serveissocials-residenciesgentgran

Figure 4. Distance of the Eixample block and the surrounding streets used to determine the buffer of the nodes



A count for all the facility points included in each node buffer is executed. In the case of the residential surface, the count is done over the housing plots of the shapefile adding all the square meters of residential use that intersect with the node buffer. All this process is made in Qgis (Figure 5).

Figure 5. Graphic model of the Qgis process



4.3 K-means clustering in R

After loading the created dataset in R, the data useful for the cluster analysis is subset (Figure 6).

Figure 6. Subset of data used for the K-means clustering calculations

	Residential sqm*	Vitality	Cultural	Restaurant	Education	Retirement home
1	71977	3	0	4	0	0
2	67866	5	0	9	0	0
3	...	...	...	...	...	...

*The residential sqm corresponds to the sum of squared meters of residential buildings

Next, data needs to be standardized between all the variables since the count of facilities may vary significantly from one to another and the square meter value of the residential surface is not comparable with the rest of the variables.

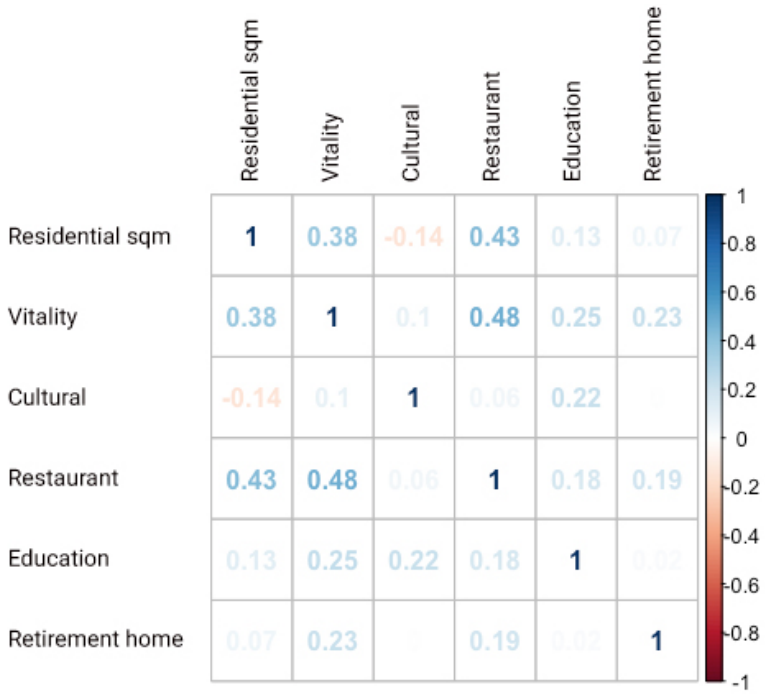
To this effect, the Z-score will be calculated for all the variables measuring the standard deviations from the mean in a group of values (Figure 7). A Z-score above 0 indicates the value is above the mean and negative Z-scores represent values below the mean.

Figure 7. Z-scores of the studied variables

	Residential sqm	Vitality	Cultural	Restaurant	Education	Retirement home
1	0.62043211	0.09853892	-0.3002524	0.02167855	-0.4045654	-0.3049078
2	2	0.49826960	0.66161844	-0.3002524	1.46691510	-0.4045654
3	…	…	…	…	…	…

In order to make sure the variables selected are meaningful and avoid multicollinearity, a Pearson's correlation matrix is visualized to check if the variables have similar distributions (Figure 8).

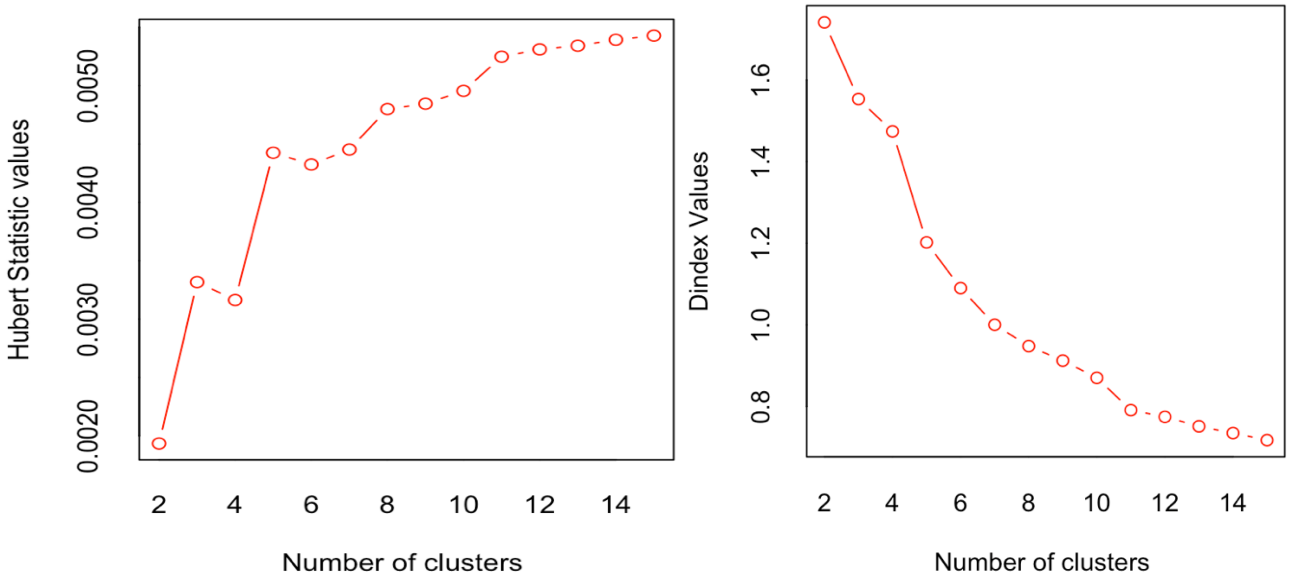
Figure 8. Pearson's correlation matrix of the variables



The highest correlation values are between Vitality and Restaurants. Since the indicator of vitality is calculated using the amount of "small commerce" it is understandable that they are spatially close to the location of restaurants. In this case, both values are useful for the analysis and kept as part of the clustering process.

Next step is to determine the appropriate number of clusters for the set of data. Since the amount of data is moderate, a complete test using the "NbClust" R package is completed. The results of the test indicate that 8 of the 23 indices analysed in the "NbClust" package recommend a number of 5 clusters. Both the Hubert index and the D index present a significant knee at the value 5 (Figure 9).

Figure 9. Hubert index and D index values



After performing the K-means clustering calculations for the 5 optimal clusters, the cluster centre points are checked in order to determine if the results have a significant meaning for the project (Figure 10). In this case, the result seems coherent and the process is finished with a total number of 5 clusters.

Figure 10. Centre point values for the 5 clusters

	Residential sqm	Vitality	Cultural	Restaurant	Education	Retirement home
1	-0.77	-0.59	-0.30	-0.77	-0.40	-0.30
2	0.10	1.37	-0.30	0.51	-0.40	2.74
3	-0.47	0.32	3.30	0.20	0.74	0.00
4	0.45	0.40	-0.30	0.24	2.45	-0.07
5	0.89	0.16	-0.30	0.69	-0.40	-0.30

5. Results

Interactive map and dynamic graphs available at http://aleixarcarons.com/pr/superblock/

The result of this brief research project is the classification of the 120 potential public spaces in the Eixample superblock plan in 5 cluster groups (Figure 11 and Figure 12).

The spatial distribution of the clusters (Figure 13) indicates that the public spaces in risk of desertification are situated in great measure in the Sant Martí district, where a substantial number of industrial activities still take place. Even so, there are several opportunities for activities involving the elderly, cultural events and school related facilities.

On the contrary, the central parts of the Eixample (the Eixample district) present higher indices of vitality and a high potential for new successful activities. Still, the "Food and drinks" category is clearly predominant.

Figure 11. K-means clustering groups result description

	Cluster name	Number of nodes	Description
1	Desertification risk	48	- Poor quantity of residential surface around - Lack of vitality - Lack of nearby activities to facilitate a symbiotic relation
2	Third age vitality	10	- Relevant number of nearby Retirement homes - Extremely high vitality
3	Cultural platform	10	- High number of cultural facilities around - Moderate impact of education facilities
4	School breaks	13	- Significant number of nearby education facilities - High vitality
5	Food and drinks	39	- High density of residential surface around - Relevant number of Restaurants and bars nearby

Figure 12. Radar plots of the centre points of every cluster group

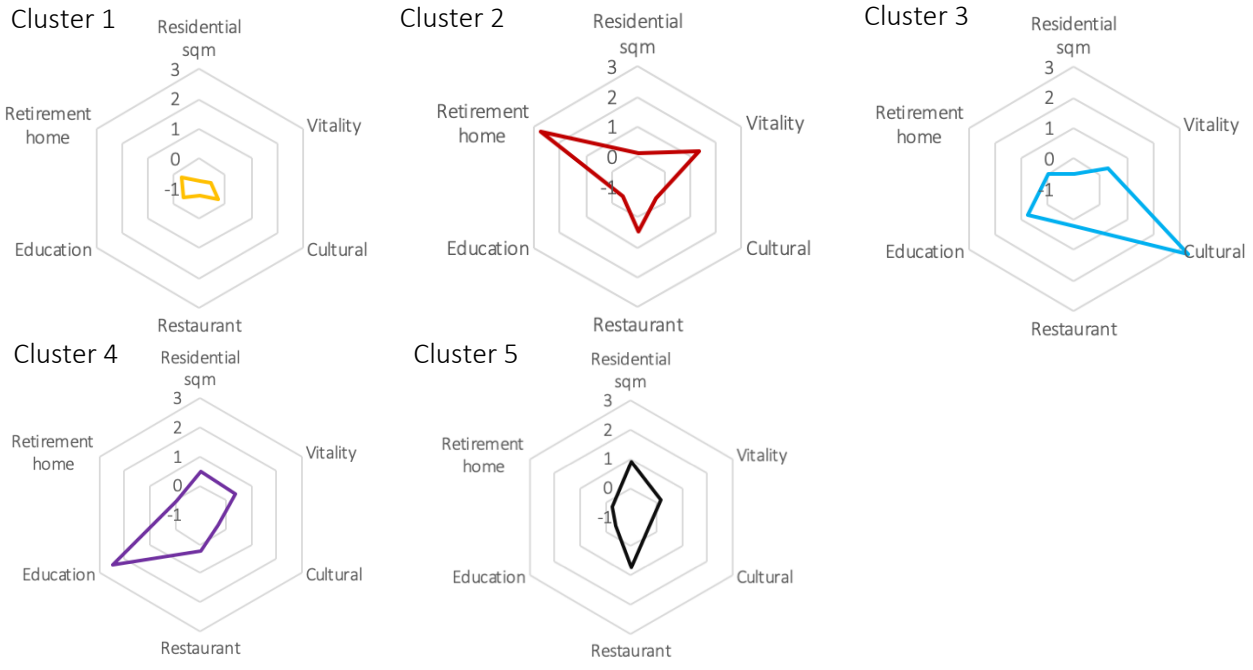
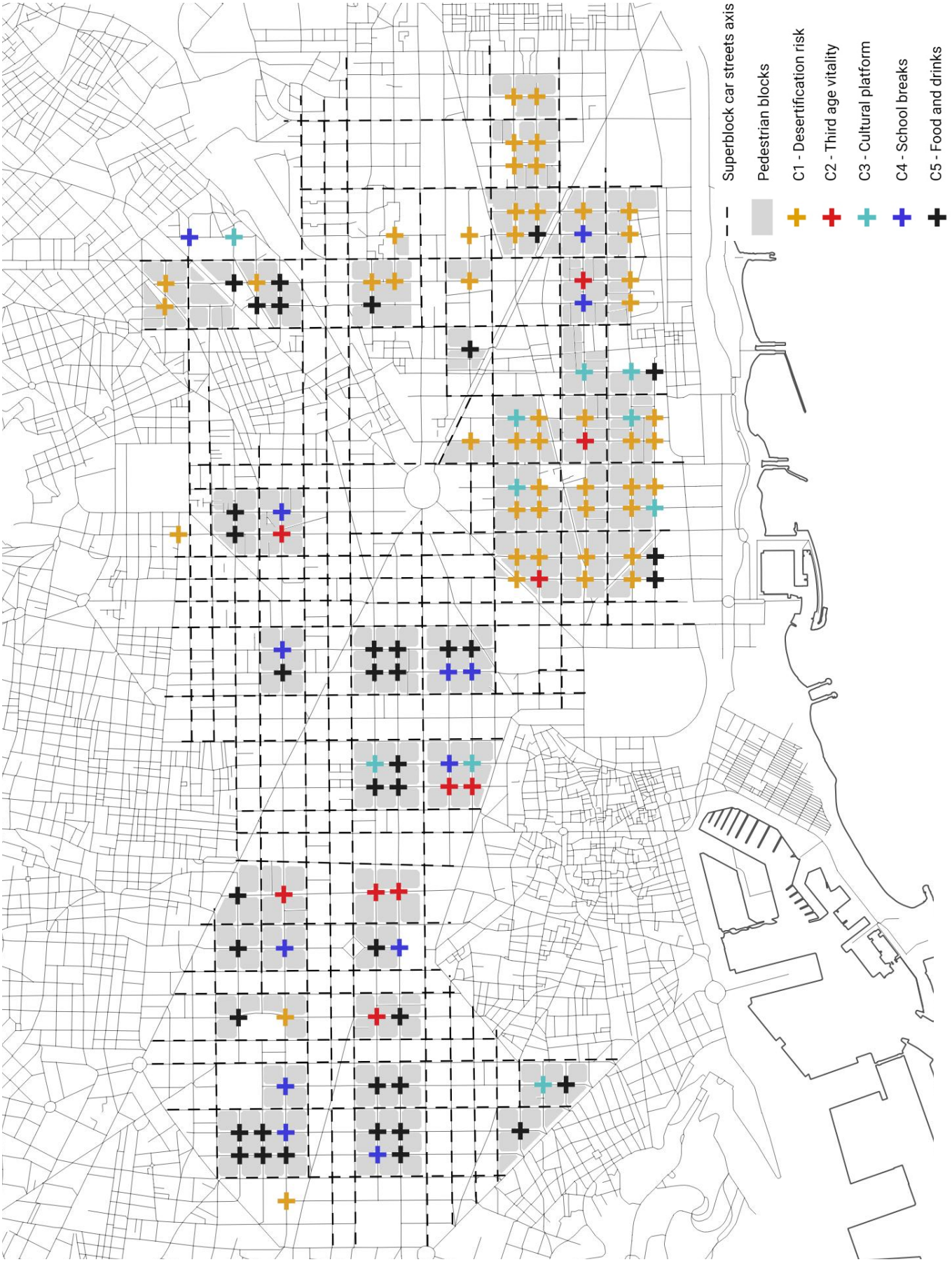


Figure 13. K-means clustering classification on the Eixample superblock nodes



6. Discussion

Although this project can offer a first idea of the future activities that can be developed in the superblocks, it represents just a small part of all the factors that can be considered relevant to make this analysis complete. Reality in the urban context of Eixample is far more complex than what the selected sets of data can portray.

Besides, the K-means clustering offers a mainly binary lecture of the results, where "Desertification risk" and "Food and drinks" groups account for a vast majority of the studied nodes. This can mean that the two relevant outcomes of the research are spaces with potentiality for success and spaces in risk on being underused.

Still, the project offers a global view of the Superblocks that can be useful to keep problems and opportunities in public spaces in mind. It would be interesting to check the results of the clustering process with the real actions already carried out in order to improve the methodology and understand what factors influence the success or failure of the public spaces in the superblocks.

7. Conclusion

The superblock plan will drastically increase the public spaces in Barcelona. Although this is a desirable outcome for a remarkably dense city, it does not come without some associated risks. It is essential to ensure that the new public spaces will not fall in disuse or will become generic design repetitions with a lack of identity.

In this sense, this research offers a global analysis of all the potential public spaces in order to propose its possible future activities and identify the cases that present lower chances of becoming a successful public space.

The Eixample superblock public spaces studied are divided in 5 categories according to its pre-existing qualities. Each one of them leads to a diverse set of considerations that should be taken in account.

The "desertification risk" category comprehends a total of 48 public spaces, being the most numerous of all. In this case, the planning associated with the public space should be strong enough to attract people from other places of the district or the city and night-time safety should be considered.

In the "Third age vitality" group, potential public spaces devoted to the aging population are identified. Simultaneously, these same spaces offer great indices of vitality thanks to the density of small local businesses. Activity in these nodes should focus on preventing the isolation of the elderly and finding synergies between different generations.

The "Cultural platform" represents those spaces that have cultural facilities around. In this case, the public spaces can be a useful platform in where to exhibit works or host public talks with the aim of making cultural events more accessible to the citizens. In some cases, proximity with educational facilities is also a factor to consider in order to find common activities for these spaces.

The "School breaks" spaces can be used as recreational during the lecture breaks or lunch time, where most of the schools in Barcelona lack space. The same space can also be used as a socializing or leisure space after classes, avoiding the dangerous massification of students in the sidewalk on rush hours.

Finally, the "Food and drinks" represent spaces that most possibly can be turned in Restaurant or Bar terraces due to the high number of this kind of businesses. This category can risk becoming a generic space due to the high number of nodes included in it. Complimentary activities should be regarded to differentiate these spaces and prevent the private businesses to indiscriminately occupy the public space.

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