Islands or Bridges? 15-Minute Cities and Weak Ties

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Abstract. The concept of the 15-minute city has recently sparked one of the most debated topics, attracting both strong supporters and vocal critics.

Among them, some warn the risk that the creation of fully walkable settlements, equipped with sufficient amenities to make them functionally autonomous from the rest of the city, could lead to segregative effects, so as to result in the formation of isolated urban areas, increasing the risks of social segmentation and reducing diversity in the social fabric.

Such an objection necessitates broadening the perspective by shifting the discussion from the intrinsic features of the neighbourhood to the question of its location within the overall system, so as to ensure that the local network of interactions and movements is properly integrated within the broader set of relationships at a global scale. Regarding the connections between different parts of a system, recent studies highlighted the strategic importance of spatial elements that act as crucial bridges between its various subsystems. These elements were defined 'weak ties' because of their strong analogy with the components identified by Mark Granovetter in his seminal theory. Despite their weak local connectivity and global centrality, they play a fundamental role in the system as a whole, in that they bind together its different parts.

This paper, after addressing the transferral of weak ties theory into a spatial logic, aims at discussing their bridging capacity as an essential requirement for the location of 15 min neighborhoods, preventing the risk of their isolation and compartmentalization.

Keywords: Weak ties · 15-minute city · Bridgeness

1 Introduction

The concept of the 15-minute city, which proposes making urban settlements more livable by ensuring the availability of essential services within a short walking or cycling distance, has sparked one of the most debated topics in recent scientific discourse since its introduction during the pandemic (Moreno et al. 2021; Allam et al. 2022). The discussion has been so intense that it has also engaged the media, attracting both strong supporters and vocal critics.

The arguments presented by proponents will not be addressed here: they are evidently so compelling that they have gained widespread public support on a global scale, far

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beyond the scientific community, making the concept itself a broadly accepted proposal in its general terms.

Among the critiques, one of the most well-founded raises the issue of the risk that the creation of fully walkable settlements, equipped with sufficient amenities to make them functionally autonomous from the rest of the city, could lead to inherently segregative effects. This could result in the formation of so-called '15-minute bubbles', compartmentalized and isolated urban areas where interactions and interpersonal relationships densely occur only within the neighbourhood, increasing the risks of social segmentation and reducing diversity in the social fabric (Market et al. 2024; Mouratidis 2024). Such dynamics could, in turn, lead to opposing risks of ghettoization, with increased marginalisation of disadvantaged neighbourhoods, or gentrification, with the emergence of high-income enclaves home to affluent residents: either islands of poverty or islands of wealth. It is a risk that is clearly apparent to Edward Glaeser, who in a recent podcast interview reports that living in a proximity city might entail "being citizens of a sort of small neighborhood, rather than citizens of an entire metropolis, that feels deeply dangerous to me, especially in America, with its history of profound racial and income segregation (…) so if you want a city that's integrated, you want to eschew the 15-minute city" (Mckinsey 2024).

Such an objection, not without merit, necessitates broadening the perspective by shifting the discussion from the intrinsic characteristics—both morphological and functional—of the urban area designated for pedestrian use to the question of its positioning within the overall settlement system. The goal is to ensure that the local network of interactions and movements—ideally pedestrian—is properly connected and integrated with the broader set of relationships at a global scale All this brings us back to the relationship between the global scale of a settlement and the local scale, corresponding to its individual parts, and to the extent to which these parts contribute to shaping the overall structure of the network, in alignment with its organization and internal geography.

Regarding the connections between different parts of a settlement system, recent studies (Cutini 2024; Altafini et al. 2023) highlighted the strategic importance of spatial elements that act as crucial bridges between the various subsystems, enabling the overall functioning of the settlement. Due to their role as bottlenecks, a significant portion of movement within the system flows through these bridges, generating a through-traffic intensity that sustains their vitality, which in turn extends to the surrounding areas. These essential elements have been defined as 'weak ties' because of their suggestive analogy with the components identified by Mark Granovetter in his seminal theory in social network analysis. Despite their weak local connectivity and low global centrality, they play a fundamental role in the system as a whole, in that they bind together the different parts of a system. This paper describes the potential and limitations in the transferral of weak ties theory into a spatial logic in order to discuss the bridging capacity as a essential requirement for the location of 15 min settlements, preventing the risk of their isolation, fragmentation and compartmentalization.

2 Weak Ties and Spatial Systems

It was some 50 years ago when Mark Granovetter, a young American sociologist, not yet thirty, submitted a paper that, initially harshly rejected, was then accepted for publication and soon became one of the most cited articles in social studies, boasting over 75,000 citations so far and providing influential insights on generations of sociologists, anthropologists and network analysts.

It introduced a notion, weak ties, that was doomed to become pivotal in social networks and to radically change their analytical approach, traditionally based on the quantity, intensity and proximity of interpersonal relationships: it was argued that also weaker interactions, even if distant, less frequent or numerous, often play a fundamental role, in that they may represent bridges between different communities so as to channel the flows of novel information all over the social system and favour its global functioning. Paradoxically, Granovetter (1973, p. 1378) argues, as "indispensable to individual opportunities and to their integration into communities", weak ties are even more important than strong ones, which on the contrary, "breeding local cohesion, lead to overall fragmentation" (Granovetter 1973, p. 1378).

Since "whatever is to be diffused can reach a larger number of people, and traverse a greater social distance (…), when passed through weak ties rather than strong" (Granovetter 1973, p. 1366), the implications of weak ties theory extend on an ample variety of fields and issues explored by social network analysis, so as to consider their role in favouring or contrasting the transmission of information, ideas, emotions, high-risk social and political movements, avantgarde fashions, and, of course, also viruses.

A few years after the introduction of this concept, Space Syntax was founded on the basis of the assumption of a city a socio-spatial system, as "society must be described in terms of its intrinsic spatiality; space must be described in terms of its intrinsic sociality" (Hillier and Hanson 1984, p. 26); or, as Hillier stated some years later, when the new approach had firmly taken root, "we should think of space not as the background of human activity, (…) but as an intrinsic aspect of everything human beings do" (Hillier and Vaughan 2007, p. 207). The interconnected nature of social and spatial issues in urban systems led to their analysis using concepts, methods, and metrics that had long been employed in social network analysis. On their turn, sociologists had adapted these tools from graph theory and network analysis when a relational approach was introduced into social studies. Let's think of the notions of configuration, introduced by Jacob Moreno and Helene Jennings (1934, 1938), degree centrality and point centrality (Bavelas 1948), closeness (Bavelas 1950), separation (Milgram 1967), clustering coefficient (Holland and Leinhardt 1971), betweenness (Freeman 1977). Those concepts, provided with a socio-spatial significant meaning, came to form a various panoply of tools, suitable for analysing both (and complementarily) the social logic of space and the spatial patterning of societies.

Considering the broad debate it has generated and its wide-ranging application, it may be questioned whether also the notion of weak ties can be imported into a configurational approach for the analysis of spatial systems, discussing the terms, limits and conditions under which this transfer is actually feasible and the prospects it may offer.

In Granovetter's theory, weak ties represent social connections between individuals who know each other but are not particularly close. According to Granovetter (1973),

interpersonal ties can be classified based on their strength—measured by factors like intensity, intimacy, and duration—into three categories: absent ties, strong ties (close friendships or frequent interactions), and weak ties (casual acquaintances). His core argument, backed by extensive empirical evidence, asserts that weak ties are crucial for fostering community cohesion and ensuring the effective functioning of the social system. Contrary to the common assumption that strong internal ties are always beneficial, Granovetter suggests that they can actually contribute to segregation and vulnerability within groups (Gans 1961; Gans 1982).

When first introduced, the weak ties hypothesis generated widespread interest and debate. A decade later, Granovetter (1983) revisited the concept, reaffirming its profound impact at both individual and societal levels. Weak ties not only enhance personal opportunities but also strengthen overall system cohesion by connecting otherwise separate communities. This idea aligns with the Watts-Strogatz model (Watts and Strogatz 1998), which shows that weak ties create shortcuts within networks, effectively making the world 'small' (Travers and Milgram 1969) by reducing the degrees of separation between individuals.

Granovetter's foundational work was later expanded by Ronald Stuart Burt (1992), who introduced the concept of structural holes—gaps within a social network that separate non-redundant contacts. Burt emphasized the advantages of these gaps, arguing that "people who stand near the holes in a social structure are at higher risk of having good ideas" (Burt 2004, p. 349). While weak ties and structural holes share conceptual roots, Burt's perspective shifts the focus to the opportunities created by the absence of ties, positioning brokers as facilitators of information exchange between different groups (Burt 2000).

Since the 1980s, when the rise of complexity science has led to the widespread application of network analysis across diverse disciplines, including biology, informatics, physics, and economics, the notion of weak ties gained a primary interest. This paradigm shift is driven by the recognition that viruses, ideas, information, emotions, technologies, trends, and fashions all spread through interpersonal networks. Since, as Granovetter observed, "whatever is to be diffused can reach a larger number of people, and traverse a greater social distance, when passed through weak ties rather than strong" (Granovetter 1973, p. 1366), the ability of weak ties to bridge different communities has encouraged researchers to explore their significance in various networked phenomena, from marketing to drug dealing, from migrations to fake news, from social movements to viruses. On this basis, unsurprisingly, studies on weak ties gained particular momentum during the Covid-19 pandemic, with a variety of research discussing both their role in the spread of the virus (Ohsawa and Tsubokura 2020; Carpio-Pinedo et al. 2021; Yang 2021) and the negative effects of their absence during lockdown (Sandstrom and Villas 2020; Carmody et al. 2022; Bertogg and Koos 2022; Long et al. 2022; Völker 2023; Schad and Hense 2023). And it is interesting to note how this peak of interest fortuitously coincided, in terms of timing, with the rising attention on the 15-minute city.

Translating the concept of weak ties into spatial terms requires a nuanced approach and careful redefinition. First, it is essential to establish the system under consideration. In a space syntax framework, which typically employs a dual graph (Hillier and Hanson

1984), it is useful to shift the focus from the connections (edges) to the spatial elements (nodes, particularly streets) and their configurational properties.

But, more importantly, the notion of tie strength calls for a different definition. According to Granovetter's theory, weak ties are connections between acquaintances characterized by low levels of closeness. While social networks allow for a spectrum of tie strengths, spatial networks are inherently more rigid, as connections in these systems are typically binary—either present or absent—without a graded continuum of strength.

Additionally, the principle of triadic closure—where two individuals with a common acquaintance are likely to form a connection—does not seamlessly apply to spatial networks. In spatial systems, the fact that two elements are both connected to a third does not necessarily imply that they will be directly connected to each other. This distinction weakens the SNA notion of communities as cohesive clusters, that in spatial terms may evolve into that of neighborhoods, that is largely isolated subsystems, with limited interconnection caused by physical separation, distance, or inadequate infrastructural integration.

Consequently, the clustering coefficient—an important measure in social networks—has a different meaning in spatial analysis. For instance, in axial analysis, the clustering coefficient of each axial line in an orthogonal grid is zero, as intersecting lines are not directly linked. However, in Visibility Graph Analysis (VGA), the clustering coefficient retains some significance, as it reflects the geometric closure within a given space.

To adapt the concept of weak ties to spatial contexts, some conceptual adjustments are then necessary. A spatial element may be considered strongly connected if it links to a large number of surrounding elements or maintains strong relationships with nearby structures. This prominence is indicated by high connectivity and integration values, reproducing the capacity of a spatial element to function as a local hub or a key global terminal. However, simply having few local connections and being deeply embedded in a network does not automatically make an element a weak tie.

Granovetter's key insight about weak ties is their ability to bridge internally cohesive but externally isolated groups. Identifying spatial elements that fulfill this role requires a focus on configurational properties. In practice, such properties align more closely with Burt's concept of structural holes—emphasizing the strategic advantage of gaps in a network—rather than Granovetter's emphasis on the relational significance of weak ties. In social network analysis, identifying structural hole spanners—elements that act as both weak ties and bridges—is a well-explored topic. Granovetter suggested that while not all weak ties serve as local bridges, all bridges should be weak ties. However, recent findings indicate that both long-range and local ties can exhibit similar strength, prompting some researchers (Neal 2022) to propose the term 'bridging ties' as a more accurate alternative to 'weak ties'.

In spatial systems, by contrast, where the principles of triadic closure and graded tie strength are not relevant, the focus shifts from tie weakness to their bridgeness. In graph theory, a bridge is defined as an edge whose removal increases the number of disconnected components in a network. Most real-world networks feature local bridges—connections between nodes that lack mutual links. Removing a local bridge increases the distance between previously connected nodes rather than severing them entirely.

Bridges, whether global or local, tend to exhibit high betweenness values, acting as critical conduits for movement and interaction within a system. This makes them essential elements in urban grids, as they often represent the shortest paths between locations. Recent researches have categorized different types of bridges based on their network roles (Ghalmane et al. 2019; Meghanathan 2021), though these distinctions become less meaningful when applied to spatial networks.

Assessing a node's 'bridgeness' involves quantifying its role as a connector. Various indices have been proposed to measure bridging effectiveness (Liu et al. 2019; Sarker et al. 2023), including eigenvector centrality and PageRank, with studies exploring their applicability to spatial systems. And spatial systems research has also explored the use of Kemeny-based centrality measures to identify bottlenecks in road networks (Altafini et al. 2023).

Yet, when the objective is simply to identify spatial connections that bridge structural gaps and link different parts of a settlement, key indicators such as betweenness and bridge degree become relevant. Betweenness is fundamental to bridging capacity since bridges typically exhibit high betweenness values. Meanwhile, bridge degree reflects a node's ability to connect otherwise distant areas. However, high betweenness alone does not necessarily indicate a bridging role, and conversely high bridgeness does not involve high betweenness: high bridge degree may characterizes the secondary branches of tree-like networks where betweenness remains low. Only nodes with both high betweenness and high bridge degree serve as effective bridges, uniting distinct areas within a settlement. These elements align with the concept of weak ties, or as Neal (2022) suggests, 'bridging ties'.

Let's consider a small system, here represented by the graph in Fig. 1. The distribution of betweenness and closeness values is chromatically described in Fig. 2.

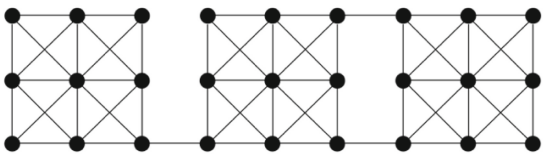

Fig. 1. Example graph

If we select, within the betweenness core, the nodes that are also provided with relevant bridgeness, we obtain the values in Fig. 3, two global bridges, nodes with ∞ bridge degree, and four local bridges, with a bridge degree 5. These are the bridging ties that play the fundamental role of binding together the parts of the system so as to allow its global working. Their removal would determine a relevant increase in the distance between the remaining nodes, when not even, in the case of the total bridge, their disconnection and the overall collapse of the system.

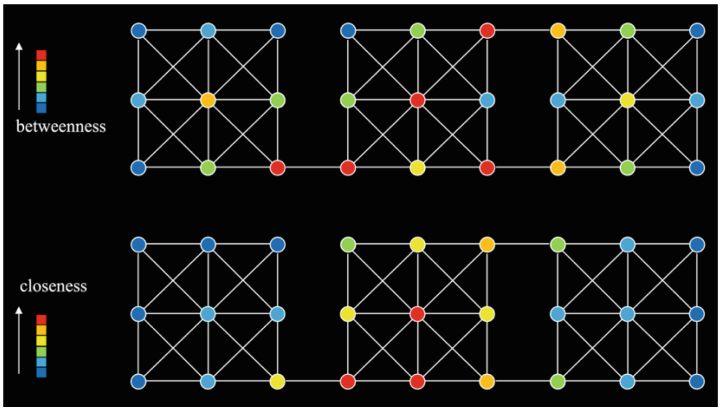

Fig. 2. Distribution of betweenness and closeness values referred to the graph in Fig. 1

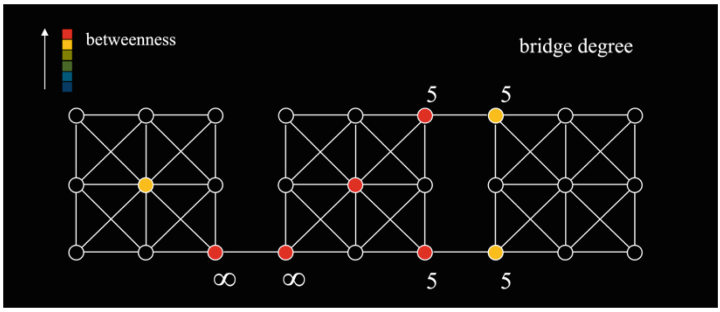

Fig. 3. Bridge degree values referred to the graph in Fig. 1

The same bridging nodes can be found if we turn to spatial systems and observe the grid of the settlement of Pontremoli, in Tuscany (Fig. 4); here the distribution of the values of betweenness and closeness is represented in the planar graph above, corresponding to the distribution of choice and integration in the segment map below. Or if we analyze the much broader system of the segment map of Venice (over 8000 segments), where the bridging ties are the segments corresponding to the three bridges that cross the Canal Grande, here in Fig. 5.

We may observe that in Pontremoli and Venice the weak ties that were detected thanks to their bridgeness are also physical bridges, since in both cases the structural hole they span is a watercourse (the river Magra in Pontremoli, the Canal Grande in Venice). Nonetheless, it's worth noticing that similar structural holes may easily occur in absence of water bodies within the urban fabric: the presence of town walls, urban highways, railway embankments, green areas, brownfields as well as scarcely connected streets similarly leads to the emergence of weak ties as hole spanners (Cutini 2024).

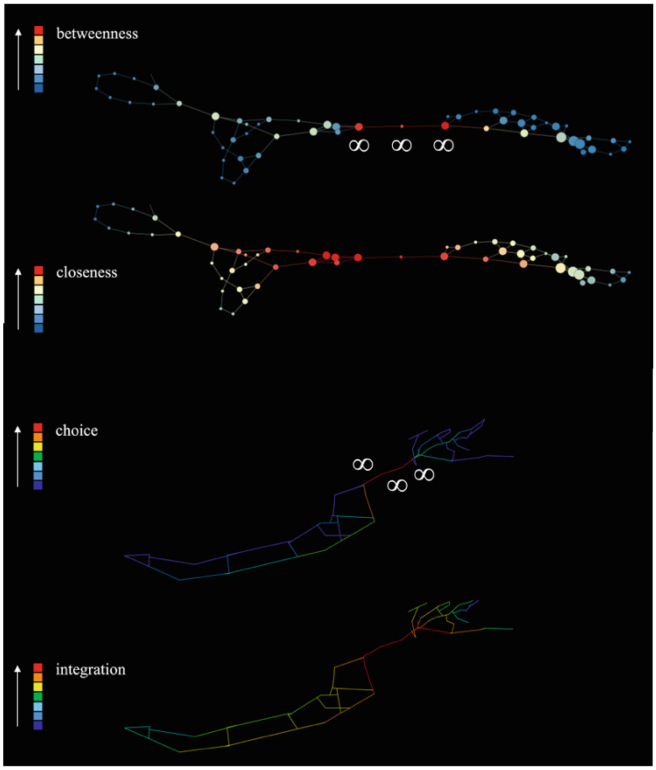

Fig. 4. Pontremoli: distribution of betweenness and closeness (above) in the planar graph, choice and integration (below) in the segment map

The capacity of bridging ties to connect neighbourhoods — and thus to channel a significant portion of the system's overall interactions — has inspired a method for identifying communities and their boundaries. This approach, introduced by Michelle Girvan and Mark Newman (2002) in the context of social and biological networks, involves progressively removing the edges with the highest betweenness values. By doing so, the network gradually breaks apart into smaller components, each representing an internal community. This same approach can be extended to spatial systems represented by segment maps, thereby revealing both the boundary of neighborhoods and the role of weak ties in interconnecting them. Applied to the segment map of Venice on the basis of the results in Fig. 5, the method allows detecting the two main neighbourhoods of the grid (Fig. 6), on the two banks of Canal Grande: what points out the fundamental role of weak ties in binding together the neighbourhoods, contrasting their segregation and compartmentalization, and short-cutting the connection of its elements, a clear small-world effect (Watts and Strogatz 1998) within the urban network.



Fig. 5. Distribution of choice values in the segment map of Venice. Circled in red the main bridging ties, with their bridge degree



Fig. 6. Main neighbourhoods in the grid of Venice, detected progressively removing the main bridging ties

3 15-Min Cities and Bridges

In light of some of the points raised in the debate on the 15-minute city, the locally pre-established conditions necessary for the development of a predominantly pedestrian-oriented settlement in a suburban area are, on the one hand, the presence of a sufficient through-movement flow to sustain activities, and, on the other hand, the easy connection of the area to other parts of the system.

This dual provision appears necessary to ensure, on the one hand, the internal vitality of the settlement through the presence of movement, activities, and essential services within a short walking distance, while on the other hand avoiding conditions of compartmentalization, isolation, and insularity in relation to the regional context: the risk against which many influential critics, including Ed Glaeser, have warned. Recent researches on mobility based on GPS data on individual trips in US cities attest a narrow correlation between local usage and segregation for poorer neighbourhoods (Abbiasov et al. 2022): so as to substantiate the risk of the possible consequence of 15-minute cities on marginalized communities, since reducing mobility across neighbourhoods could exacerbate their social isolation (Moreno and Veltz 2022). And also to reaffirm Glaeser's blunt criticism: "A 15-minute city is not really a city at all. It's an enclave - a ghetto - a subdivision. All cities should be archipelagos of neighbourhoods, but these neighbourhoods must be connected" (Glaeser 2021, p. 1).

In such a view, it is essential to adopt a network perspective, and the best guarantee that a 15-minute suburban neighbourhood will not be isolated is for it to be anchored to a main street that functions as a weak tie within the whole system. In such a condition, the bridgeness of its main street is likely to ensure the neighbourhood both a significant share of through movement within the system, thanks to the channelling effect of traffic flows, and close connections to its other parts, due to the strategic pivot role in paths distributions. This requirement ought to be satisfied as a precondition, leaving aside the other several aspects, referred to the intrinsic features that characterize the neighbourhood, making it more or less suitable for being transformed into a 15-minute neighbourhood: this refers to the characteristics of the built environment, the sufficient presence of economic activities, the absence of uses incompatible with residential functions, the absence of natural or landscape constraints, and the compatibility with guidelines derived from the regulatory and planning framework. In other words, the actual role of a bridging tie reflects the potential of a road element located in a suburban area to effectively function as the main street of a vital and well-connected settlement— a precondition that can be realized if various intrinsic requirements are met and no obstructive conditions or constraints exist. The example of the conurbation that has developed in recent decades around the city of Lucca, the so-called *Piana Lucchese*, can be presented as a case in point. This is a suburban area that has developed with low-density urbanization around the compact core of Lucca, an ancient city, to the point that it now covers an area more than 20 times larger than its original nucleus.

Within the historic core of Lucca, the segments with the highest choice values correspond to the main axes of the ancient Roman layout, where the densely connected orthogonal grid does not present bridges. Minor bridging ties emerge in correspondence of the ancient gates of the Renaissance townwalls, that, still existing, remain as a physical diaphragm, a circular structural hole between the inner core and the extra-moenia

early development (Cutini 2024). Outside the city walls, the highest values of the same index correspond to some of the radial roads extending from the historic centre and connecting it to the surrounding settlements, mainly on the Eastern side of the city. If we select, among the segments with highest values of choice (which form the so-called choice core), those that also show a high bridge degree (Fig. 7), we can detect the main bridging ties of the system: the spatial elements that meet the necessary territorial preconditions—namely, the configurational network potential—for local densification interventions aimed at fostering the development of suburban proximity neighbourhoods that are also well integrated within the whole grid of the conurbation. Assessing the intrinsic characteristics of each of these areas will make it possible to determine whether such a proposal is actually feasible or, conversely, if local specificities make it unrealistic or unsuitable.

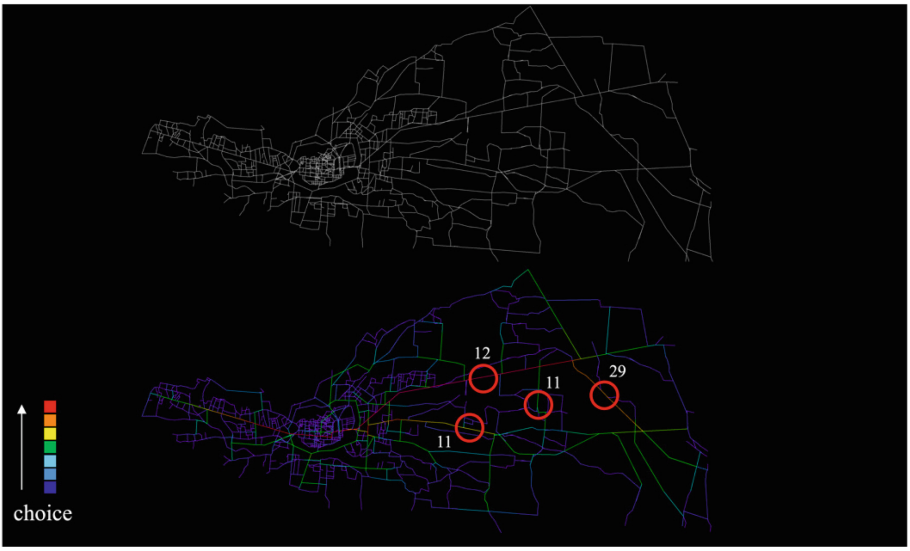

Fig. 7. Distribution of choice values (below) in the segment map of Lucca conurbation (above). Circled in red the main bridging ties, with their bridge degree

4 Conclusions

This paper connects the concept of the 15-minute city with that of weak ties, two topics that interestingly, for entirely different reasons, captured significant attention in the scientific debate during the recent pandemic. The discussion on the 15-minute city concept, its usefulness, feasibility, and the specific features that its spatial organization must possess to meet the needs that motivate it is not among the aims of this contribution. Rather, it seeks to highlight that the compliance with guidelines regarding specific morphological and planimetric characteristics is not in itself sufficient to ensure the successful outcome of a settlement aimed at functioning as a lively, livable, and well-integrated proximity

city: a predominantly pedestrian-oriented settlement in a suburban context must meet certain preconditions regarding its location with respect to the global grid. Without these, the neighbourhood risks becoming an isolated, compartmentalized enclave, disconnected from other parts of the settlement—as eminent critical voices, not without reason, have warned. These preconditions concern the presence of through-movement flows, a necessary lifeline to sustain its vitality and attract economic activities, as well as strong connections to the broader settlement grid. Both aspects are largely ensured when one of the streets around which the settlement is organized serves as a bridging tie to the global system, or, to honour the influential Mark Granovetter's insight and evocate its origins in social network studies, a weak tie: that is an element that, even if deprived of global and local integration and connectivity, serves the crucial function of bridging the structural holes within the system, so as to bind together its single parts.

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