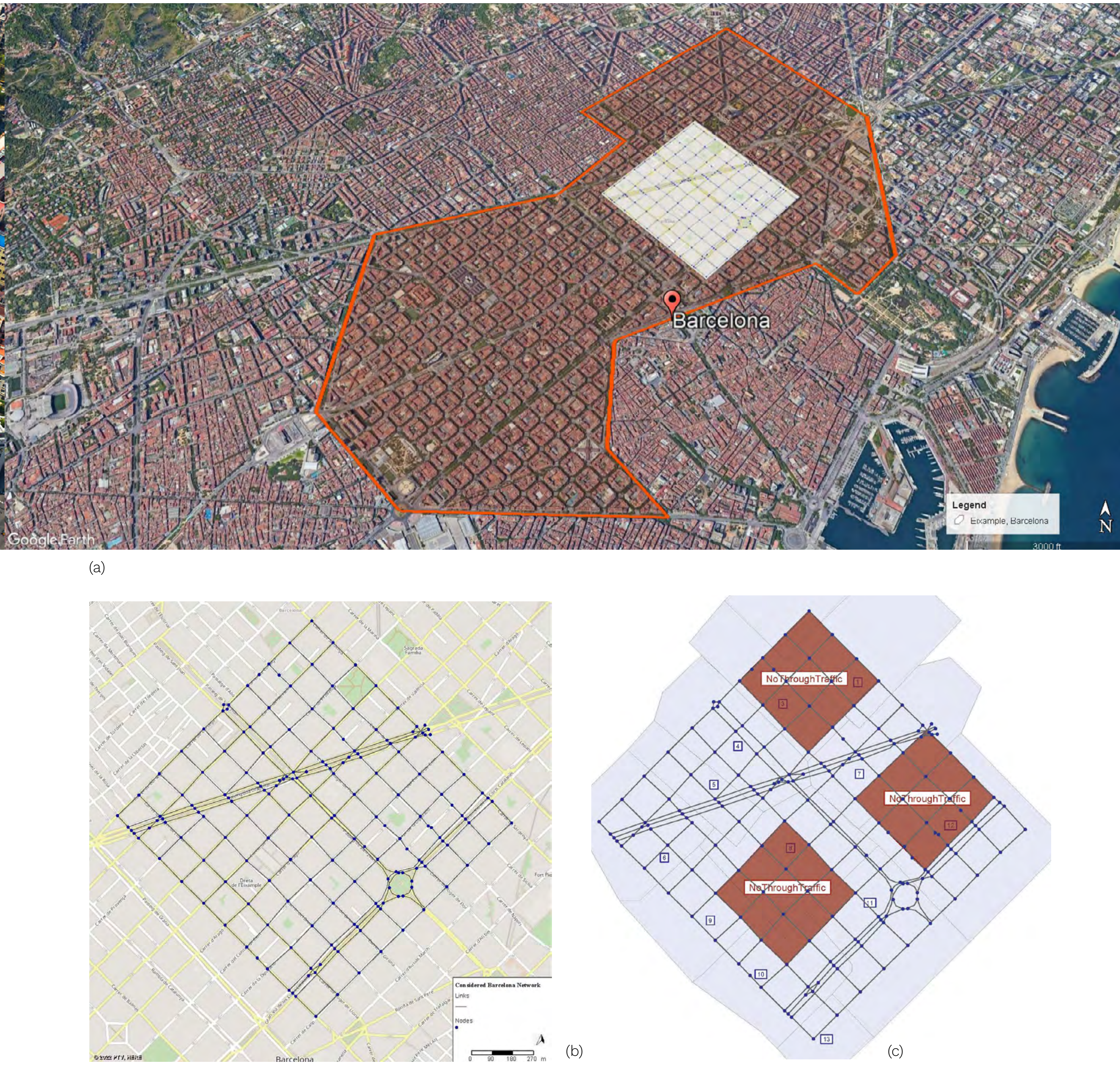
Unlocking the Future: Barcelona’s Superblocks in the Transition to Full Automation.

BY SAMRA SARWAR

The “Eixample” district of Barcelona



(a)

(b)

(c)

Figure 1. (a, b) Considered area of Barcelona; (c) Road network of considered area with superblocks.

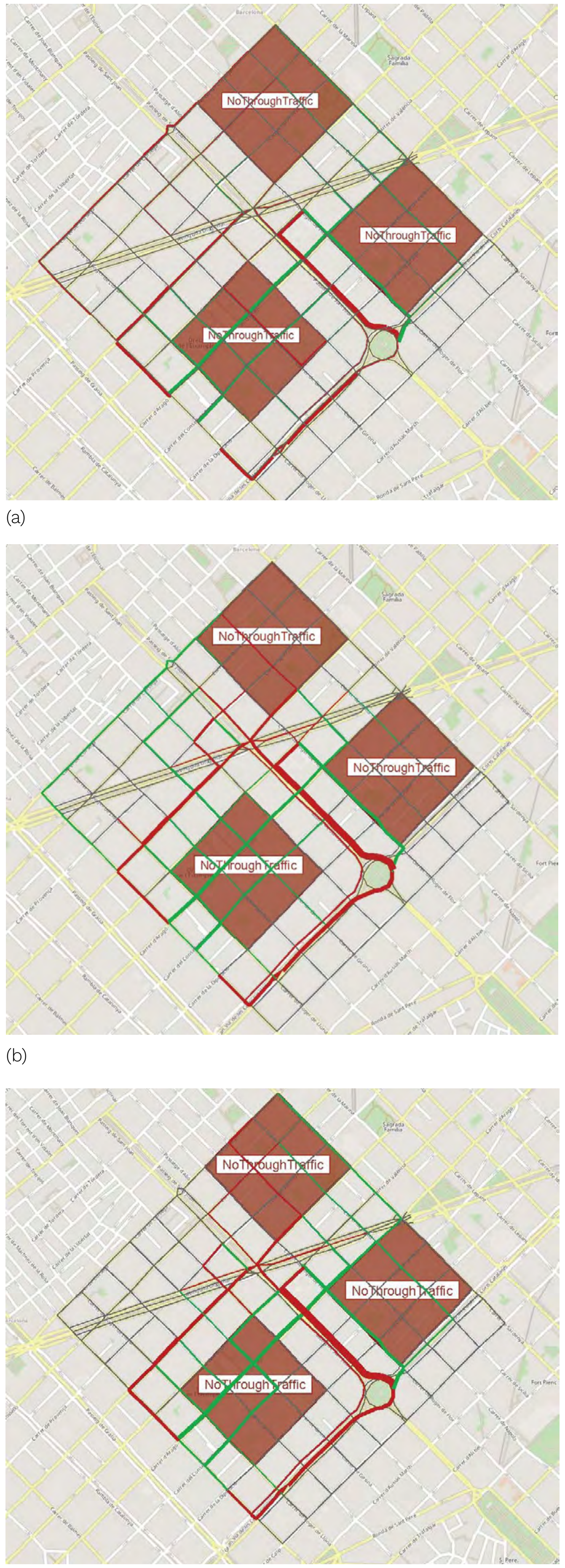
By incorporating Autonomous Vehicles (AVs) in the environment, the performance of the transportation network notably improves in terms of traffic flow. With 100% penetration of AVs in the network there will be a 33% increase in traffic flow at the same density.

A future vision of urban mobility planning concerns the condition of traffic and mobility in general with the integration of automated vehicles (AVs) into the road network. With an increasing trend of the global population mainly living in urban areas, approximately 70% by 2025, more cars will be on the road network as many cities are car-dependent.

The planning of vehicle-dependent cities across the world with emerging technologies like automated vehicles must be amended to make them pedestrian-friendly. Therefore, there is a need to reorganise the urban streets to create more spaces for pedestrians, even with the presence of automated vehicles (AVs). The implementation of a superblock model within the framework of automated vehicles holds significant promise for expanding pedestrian-friendly zones. In the superblock model, cut-through traffic demand is restricted, and traffic generated or attracted to a superblock can have access, allowing for more room for public spaces. The proposed model is applied to a small network in the “Eixample” district of Barcelona, as shown in Figure 1 (a), (b), and (c) during the transition phase from traditional vehicles to a fully automated environment. The considered network covers an area of 1.33 km^2 comprising of 13 zones, 193 nodes and 684 links. This district has a perfect grid-like street structure, which represents the perfect picture for the superblocks’ network. Eixample covers 16.2% of the total area of Barcelona city, and 2115 trips/day take place in this neighbourhood which is approx. 30% of trips/day of Barcelona city (7224 trips/day), which has only 2m^2 urban green/hab. The aim is to utilise this relatively small network area with actual OD matrices representing the regular hourly daily traffic, to facilitate the initial execution of the proposed model and maintain simplicity in the analysis. The equilibrium assignment Bi-conjugate Frank-Wolfe network is used while adopting different penetration rates of AVs. After analysis it is evident from Figure 2 (a), (b), and (c) that the demand in the network shifted from restricted routes towards the concerned links using the shortest path method. It is observed in Figure 2 (a) that the volume difference outside the superblocks on the concerned links when there are 0% AVs in the network, with the inclusion of superblocks, reaches saturation. Similar trends are also observed in the network, with 40% AVs and 100% AVs in the presence of superblocks.

As depicted in Figure 3 (a), (b), (c), and (d), we can witness that the flow capacity increases with a higher share of AVs. Human drivers have a reaction time of 1 second, while AVs have a reaction time of 0.6 sec. Thus, capacity and wave speed increase with a higher proportion of AVs, and this, in turn, affects the macroscopic fundamental diagrams (MFDs). Since traffic flow is a function of traffic speed, Figure 3 (a), (b), (c) and (d) present the Macro Fundamental Diagrams (MFDs) of the selected Barcelona network, comparing 100% traditional vehicles in the network with 40% AVs and 100% AVs in the presence of superblocks respectively. Figure 3 (a) shows an approximate 18% increase in flow at the same density with 40% AVs in the network, while Figure 3 (c) shows an approximate 33% increase in flow at the same density with 100% AVs. Therefore, the speed-density and flow-density relationship depicts that with the inclusion of AVs in the network containing superblocks, the capacity of the transport links will increase as the link flow increases accordingly. Overall, the network with superblocks and traffic in the network containing AVs have more benefits over costs.

The results from the application of the model to the Barcelona network reveal the positive impacts of superblocks in a network with a mix of AVs and traditional vehicles in the traffic flow. Various traffic parameters, including V/C, volume difference, and total travel cost, are computed. The findings indicate improved traffic network performance in terms of the level of service (LOS). The results revealed that the V/C ratio on concerned links outside superblocks without AVs is more than 1. With 40% AVs, LOS is improved, with a V/C ratio of less than 1 on the majority of links. Furthermore, with 100% AVs in the network, the LOS is significantly improved because the V/C ratio on significant links is even less than 0.7, as shown in Figure 4 (b) and (c). The cost-benefit analysis demonstrates that, despite an increase in the cost objective function after optimising the optimal location, the benefits are approximately 52% more than the cost of the system when having a demand factor (y) of 500, with 20% of the city's area covered by superblocks with 100% AVs compared to traditional vehicles. In a nutshell, we conclude that a network with superblocks with AVs in a system will reduce the generalised travel cost by reducing the costs of social externalities and travel time.



(a)

(b)

(c)

Volume difference 🟩 <=0 🟥 >0

Figure 2. (a, b, c)

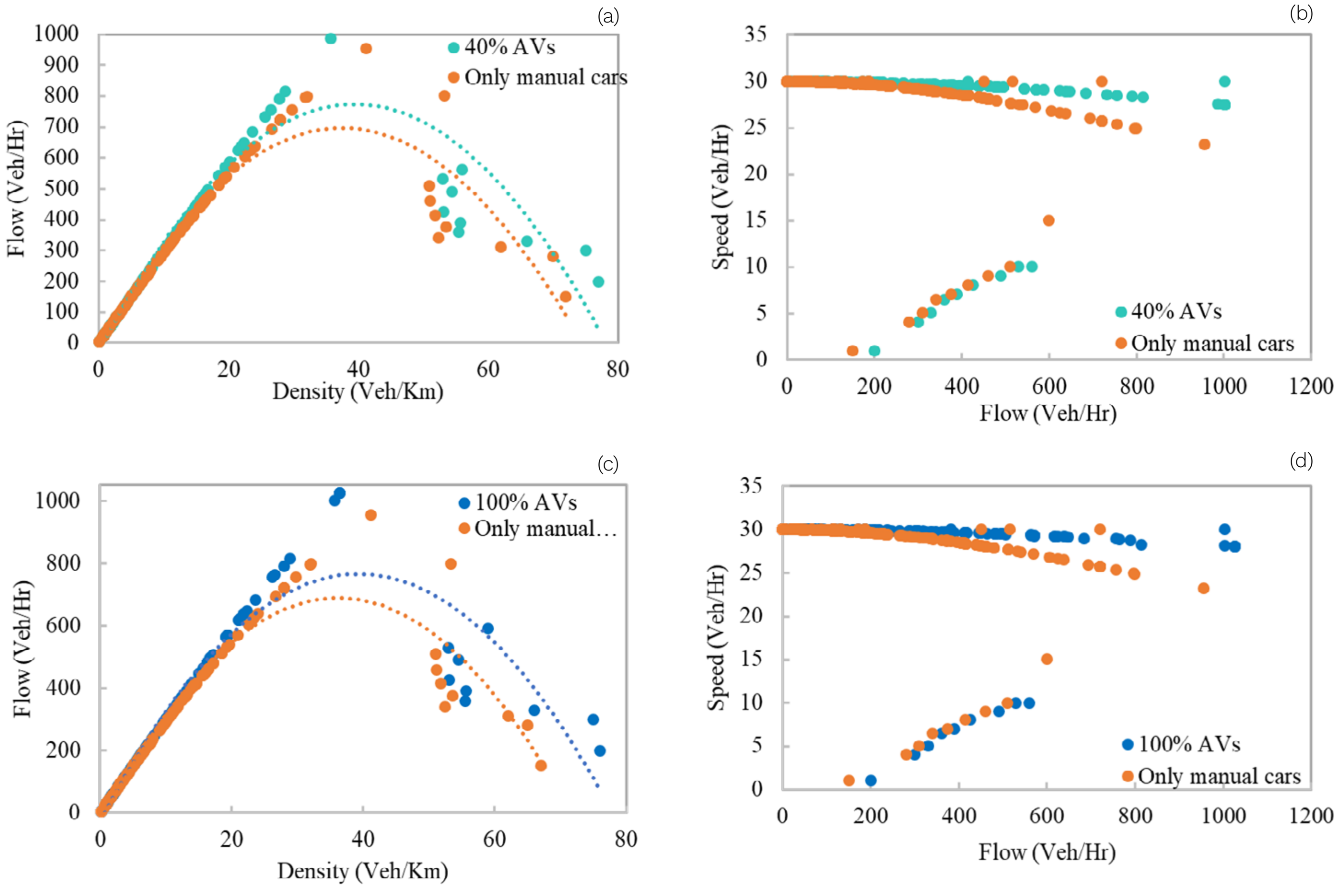


Figure 3. (a, b, c, d)

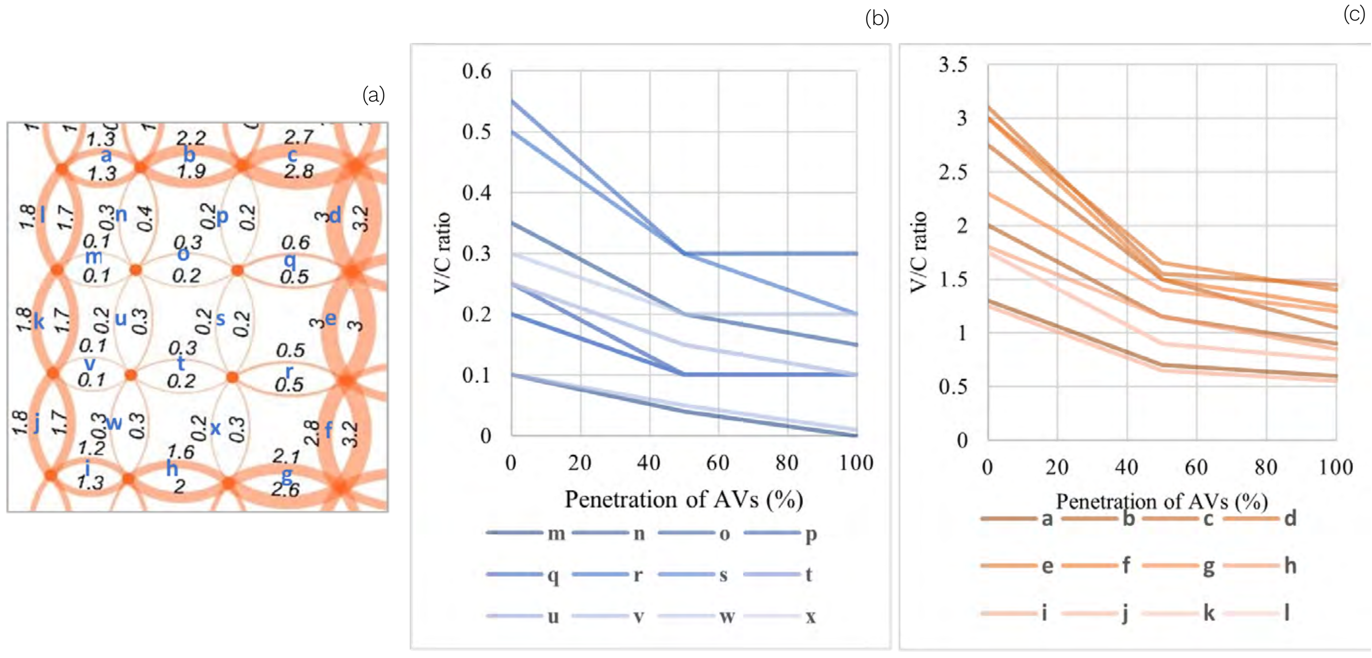


Figure 4. (a, b, c)