PLOS ONE submission: Response to reviewers

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Thank you for for the time and care taken by the editorial team and reviewers in providing feedback to the second round of revision to the manuscript. No doubt, the further revised version submitted is more articulate than the first. Our responses to comments to Reviewer #2 are shown below in blue.

Reviewer #2:

I appreciate the fact that the authors have largely revised the paper to answer the reviewers' comments. Still, I feel like some of my comments have been insufficiently addressed in the revised draft, as detailed below.

Thank you: comments provided by all reviewers were exceptionally helpful in clarifying the manuscript. We address the outstanding three comments and additional minor comments in this response letter.

The authors have adequately addressed my comment on the fact that their new measure is not useful for studying access to non-competitive resources in the revised introduction.

We added additional detail to the "Introduction" (second paragraph) to further clarify. Specifically, that opportunity congestion can be seen on continnum and that accessibility methods that consider competition have been increasingly applied to analyse access to opportunity types that are not inexhaustible such as educational facilities [@kelobonyeMeasuringAccessibilitySpatial2020a; @liMeasuringMultiactivitiesAccessibility2024a], greenspace and recreation [@wuWillOpeningCommunity2020; @liMeasuringMultiactivitiesAccessibility2024a], and shopping [@kelobonyeMeasuringAccessibilitySpatial2020a; @chenEnhancingTwoStepFloating2019].

My comment on the fact that the new measure doesn't allow to study the absolute gains or losses in accessibility from public transport or land use system changes has inadequately been accounted for. First, what your new measure can or cannot do remains unclear to me: for instance, how would an improvement in the transport sector that benefits all transport modes and locations uniformly, but still reduces all transportation times in the city, be accounted for? Second, I do not see where this point is discussed in the paper.

Interesting and thoughtful comment. We have added further detail to the text to the "Discussion and Conclusions" (final paragraph) to further shed like on 'competition' and make spatial availability's use case more clear in the closure of the manuscript. In the scenario described, a multiple mode (equal travel impedance) in a uniformly distributed population/opportunity landscape, will yield spatial availability before- and after- values that are equal. This is because competition has not changed: spatial availability allocates 'opportunities' in a proportional way based on competition. Competition is a product of the relative travel time (between zones) as well as the supply and demand of population and opportunities, so if those relative differences remained unchanged between interventions then spatial availability remains unchanged as well. Though what would decrease are the system-wide transport costs, and those can be reflected without an accessibility measure. Hopefully the addition of the last paragraph in the discussion clarifies this point about competition considerations within accessibility measures.

My comment on modal shift has partially been accounted for. A key question is whether people can shift transport modes easily or not: indeed, it seems to be that your new accessibility measure, based on competition, does only make sense in case people cannot easily shift transport modes. You partially answer that question in the paragraph starting l46 by explaining why some populations, e.g. children, elderly, or single parents, might have different characteristics in terms of transportation choice and mode use. Still, in the case of the Madrid LEZ, you do not explain why private cars and public transport users are in competition. For instance, you state that "restrictions to travel by car leave more spatially available opportunities for non-car-users" (l585). But it seems to me that the LEZ aims at promoting a modal shift toward less polluting cars, public

transport, or active modes rather than favoring public transport users? Relatedly, your measure does not make any difference between car users that can easily shift to public transport, and car users that cannot.

Thank you for your comment, we've further amended the "Results" (first and second paragraph) to make the assumptions within and interpretation of the empirical example more clear. The fourth paragraph in the "Discussion and Conclusions" also touches on your comment. There is no mode-shifting that occurs in the empirical example. This implementation of spatial availability assumes that all employment opportunities are available to the entire population. What impacts the proportional allocation is the relative travel cost (based on observed modal origin-destination travel behaviour from the travel survey) and the relative amount of the mode-using population residing in the zones. Fig 5 demonstrates the zonal multimodal spatial availability values based on the selected mode, observed home-to-work travel patterns, and competition to work. It is only a snapshot of travel behaviour as informed by the 2018 travel survey (i.e., the majority of cars do not enter the LEZ centro), that we use to demonstrate the multimodal spatial availability landscape. In this context, we discuss the impact that the travel behaviour induced by the LEZ centro has on the spatial availability landscape. As written in "Discussion and Conclusions", accessibility indicators are not designed to work as modal split models. "In our empirical example we used data collected after the introduction of LEZ Centro. However, given a modal split model to predict model shares, accessibility indicators, including spatial availability, can be used to investigate changes to the accessibility landscape. A similar logic can be applied for destination choice." I hope this is a comprehensive response (and manuscript amended) to address your comment. The empirical example in the manuscript does not deal with the change from one mode to another, it only looks at the snapshot of travel behaviour as recorded in the 2018 travel survey. Investigating mode-shift would be a different research motivation.

My other comments have been accounted for, and the writing of the paper has largely been improved.

Finally, I have a few additional minor comments:

Fig 5: the boundaries of the LEZs, and in particular of the LEZ centro, are really hard to see.

There is a typo l56: "The paper rest of the paper"

Thank you bringing these comments to our attention. We have changed the colours and slightly increased the size of the spatial borders for LEZ Centro and M-30 on all figures (now the borders are Pink and Purple instead of light grey and medium grey) to improve visibility. We have also corrected the identified typo. Additionally, we have improved phrasing and corrected minor grammatical errors throughout the manuscript.

Again, thank you for your thoughtful comments through the revision process so far.