The impact of operational quality in public transportation: The case of TransJakarta

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- This brief explores findings from a study that empirically analyses a large expansion of the public bus system in Jakarta, Indonesia to understand its effects on ridership and learn about commuter preferences, using model simulations to characterise optimal designs for the bus network.
- Commuters are 2.4-4.2 times more sensitive to wait time, compared to travel time on the bus. Riders on non-BRT routes (i.e. buses without dedicated travel lanes) are particularly averse to waiting at bus stops.
- Passengers are indifferent to transfers, beyond their impact on total travel time and wait time.
- Expanding the bus network, as opposed to concentrating operations intensively in the city centre, would lead to increased commuter welfare and ridership.
- Study findings may help inform how TransJakarta, the public bus operator in Jakarta, Indonesia, allocates resources in the future.
- This project highlights the potential for urban transportation providers in low- and middle-income countries to leverage the vast data generated in day-to-day operations to optimise their networks.

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Introduction

The urban megacities of the developing world face severe traffic congestion and barriers to mobility, affecting lower-income residents. While effective urban transportation is central to functioning and productive cities (Bajpai, 2018; Bryan, Glaeser, and Tsivanidis, 2020), we know little about how such large, interconnected transit systems should be organised to best serve passengers. Bus operators face limited resources and high operating costs, while managing complex, interconnected systems.

LMIC cities are moving towards centralised operations of public transport, creating opportunities for optimisation

Urban transport in many developing cities has arisen from a patchwork of private mini-buses or bus taxis. While this may offer some flexibility to organically provide service where demand exists, researchers have also shown that private provision is rife with inefficiencies due to imperfect competition, unsafe driving, and agency problems (Conwell, 2023; Habyarimana and Jack, 2015; Johnson et al., 2005; Kelley et al., 2022; Lane et al., 2023).

Against this backdrop, many cities are increasingly centralising planning and operations of public transport systems. For example, over the last 20 years, the number of cities with a Bus Rapid Transit (BRT) system has grown from 39 to over 180 (BRTData.org, 2023).

The stakes for designing effective public transport networks are high. These systems are costly and, if designed poorly, can have low ridership or even make traffic congestion worse (Gaduh et al., 2022; Gaduh et al., 2019). On the other hand, centralisation offers the opportunity to think holistically about optimal network design for entire cities, with potentially massive efficiency gains. It also tends to entail the centralised collection of vast amounts of administrative data from tap cards, bus GPS, and other relevant sources that, when leveraged effectively, can provide powerful empirical insights for city-wide network design.

Overview of the research

When considering trade-offs between extensive geographic coverage, frequent service on each route, and connected vs. direct routes, the right choices depend on individual preferences for waiting times, travel times, and transfers. This study sheds light on commuter preferences by leveraging a major expansion of the bus network in Jakarta, Indonesia, in which TransJakarta, the public bus operator, tripled its routes and doubled the number of buses in operation between January 2016 and February 2020. Researchers worked together with TransJakarta to model the effects of this expansion on ridership and aggregate trip flows across its 120-mile network.

Using detailed ridership data and aggregate travel flows from smartphone data, the research analyses how new direct connections, changes in bus travel time, and wait time reductions increase ridership and overall trips. By observing how the network expansion improved service along different dimensions and the resulting patterns of increased ridership, the study estimates a demand model that reflects how commuters in Jakarta value different dimensions of service quality. It then uses the demand model to simulate an optimal network design.

Findings

The ridership gains from adding a new route depend on how the route fits into the existing network

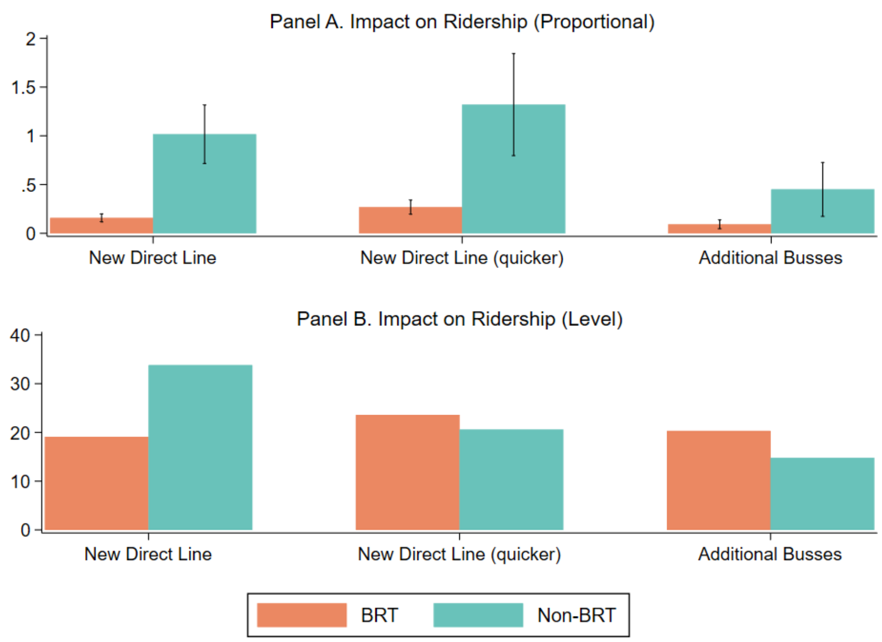
This study measures the impact of three types of changes induced by the launch of new routes. First, it finds a 16% increase in ridership when two locations went from being connected using transfers to being directly connected, in cases when the new route had a similar travel time as previous connections. Second, the effect on ridership was larger, increasing by 27%, when the new direct route was also faster than the existing transfer connections. Third, ridership increased by 9% when the launch of a new direct route increased the frequency between two locations that were already directly connected.

The third type of event implies that a 10% decrease in wait times leads to a 2.9% increase in ridership on BRT routes, while for non-BRT routes this elasticity is 1.05%. These results are not due to TransJakarta passengers being displaced from existing routes.

Similar types of changes for non-BRT bus routes have larger proportional effects, yet similar effects in levels, reflecting lower baseline ridership on non-BRT routes (Figure 1).

Looking across all modes of transportation in the city – TransJakarta and otherwise – we did not find that aggregate trip volume increases after any of these events. Taken together, these results imply that commuters shifted from other, predominantly private mobility options to TransJakarta.

FIGURE 1: Impact of new routes on ridership of BRT and non-BRT routes



Note: The y-axis measures impact on ridership on a log scale in panel A and in levels (ridership per week at the origin-destination level) in panel B

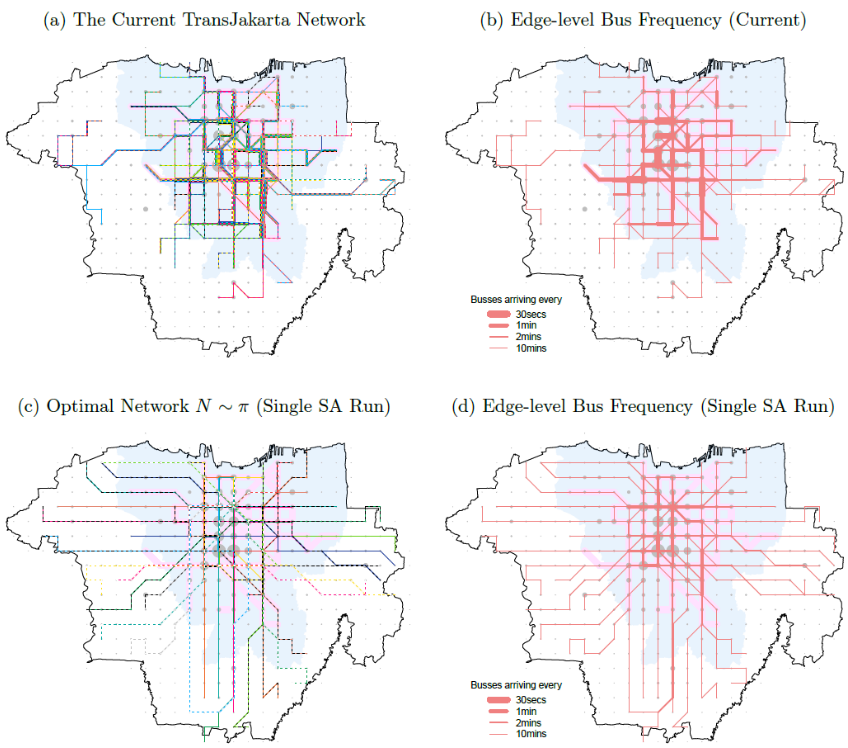
Commuters dislike waiting for the bus but are indifferent to transfers

The study has two key results on commuter preferences in Jakarta. First, commuters are 2.4-4.2 times more sensitive to wait time for the bus than time spent on the bus. This may capture the uncertainty in wait times and differences in the experience of waiting compared to riding the bus. This effect is stronger for non-BRT than BRT buses. Second, the pure transfer penalty – dislike for transfers above and beyond travel time and wait time – is small and not statistically significant. (Transfers may still be significantly costlier than direct connections, for example because they involve waiting for buses twice.)

A more dispersed network would be better

The current TransJakarta network is highly concentrated in the city's urban core, with few routes connecting to the outskirts. Using the estimated demand model, this study suggests that the optimal network is less dense and more extensive, connecting 57% more locations. In the optimal network, 39% of all pairs of locations in the city are connected by either a direct or transfer bus connection; in the current network, only 12% are (Figure 2). Despite the high value that commuters place on wait time, the estimated benefit of shifting to the optimal network (measured in terms of equivalent variation) would be the same as shaving 23 minutes off the travel time for each bus user in the current network.

FIGURE 2: Comparison of the current vs. optimal TransJakarta network



Conclusion

Study findings may help inform how TransJakarta, the public bus operator in Jakarta, Indonesia, allocates resources in the future – whether they take into consideration general insights from the study (e.g., that a more dispersed network would increase commuter welfare), or use the demand model to directly propose or compare potential new routes.

This project also highlights the opportunity for other urban transportation providers in low and middle-income countries to similarly leverage the vast data generated in day-to-day operations to optimise their networks.

References

Bajpai, Jitendra. 2018. “An Agenda for Urban Access.” Blog post. Infrastructure & Urbanisation. February 12, 2018. https://voxdev.org/topic/infrastructure-urbanisation/agenda-urban-access.

BRTData.org. 2023. “PANORAMA PER YEAR.” https://brtdata.org/panorama/year/.

Bryan, Gharad, Edward Glaeser, and Nick Tsivanidis. 2020. “Cities in the Developing World.” Annual Review of Economics 12 (1): 273–97. https://doi.org/10.1146/annurev-economics-080218-030303.

Conwell, Lucas. 2023. “Subways or Minibuses? Privatized Provision of Public Transit by Lucas Conwell.” SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4489658.

Gaduh, Arya, Tadeja Gračner, and Alexander Rothenberg. 2019. “‘Second-Best’ Bus Rapid Transit and Traffic Congestion in Developing Countries: Lessons from TransJakarta.” Infrastructure & Urbanisation. November 29, 2019. https://voxdev.org/topic/infrastructure-urbanisation/second-best-bus-rapid-transit-and-traffic-congestion-developing-countries-lessons-transjakarta.

Gaduh, Arya, Tadeja Gračner, and Alexander D. Rothenberg. 2022. “Life in the Slow Lane: Unintended Consequences of Public Transit in Jakarta.” Journal of Urban Economics 128 (March): 103411. https://doi.org/10.1016/j.jue.2021.103411.

Habyarimana, James, and William Jack. 2015. “Results of a Large-Scale Randomized Behavior Change Intervention on Road Safety in Kenya.” Proceedings of the National Academy of Sciences 112 (34): E4661–70. https://doi.org/10.1073/pnas.1422009112.

Johnson, Ryan M., David H. Reiley, and Juan Carlos Munoz. 2005. “‘The War for the Fare’: How Driver Compensation Affects Bus System Performance.” Working Paper. Working Paper Series. National Bureau of Economic Research. https://doi.org/10.3386/w11744.

Kelley, Erin, Gregory Lane, and David Schonholzer. 2023. “How Providing Information Can Improve Safety: Evidence from Kenya’s Informal Public Transit Sector.” Blog post. Infrastructure & Urbanisation. January 17, 2023. https://voxdev.org/topic/infrastructure-urbanisation/how-providing-information-can-improve-safety-evidence-kenya-s-informal-public-transit-sector.

Lane, Gregory, David Schonholzer, and Erin Kelley. 2022. “Information and Strategy in Lemon Markets: Improving Safety in Informal Transit.” Text. PEDL. October 13, 2022. https://pedl.cepr.org/publications/information-and-strategy-lemon-markets-improving-safety-informal-transit.