

Rapid Synthesis

Planning Mass-transit Projects

10 December 2020



HEALTH FORUM



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**Rapid Synthesis:
Planning Mass-transit Projects
Three-day response**

10 December 2020

Forum+

The goal of Forum+ is to generate action on the pressing social-system issues of our time, based on the best available research evidence and systematically elicited citizen values and stakeholder insights. We aim to strengthen social systems – locally, nationally and internationally – and get the right programs, services and products to the people who need them. By social systems we mean the following government sectors and program areas: citizenship, children and youth services, community and social services, consumer protection, culture and gender, economic development and growth, education, employment, financial protection, food safety and security, government services, housing, infrastructure, public safety and justice, recreation, and transportation. With Forum+, we are building on McMaster’s expertise in advancing human and societal health and well-being.

Authors

Michael G. Wilson, PhD, Assistant Director, Forum+, and Assistant Professor, McMaster University

Kerry A. Waddell, M.Sc., PhD student, Technical Focus Point, RISE (Rapid Improvement Support and Exchange), McMaster University

Timeline

Rapid syntheses can be requested in a three-, 10-, 30-, 60- or 90-business-day timeframe. This synthesis was prepared over a three-business-day timeframe. An overview of what can be provided and what cannot be provided in each of the different timelines is provided on the Forum’s Rapid Response program webpage (www.mcmasterforum.org/find-evidence/rapid-response).

Conflict of interest

The authors live in a neighbourhood in Toronto, Canada that is close to a current planned transit project.

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KEY MESSAGES

Questions

In relation to planning mass-transit projects, this rapid synthesis addresses four inter-related questions.

- 1) What is the importance of transit to communities and large cities?
- 2) What are important health, social and economic trade-offs of above-ground versus below-ground mass-transit systems?
- 3) What is the role of mass transit as part of multi-purpose-built environments and impacts on community health and prosperity?
- 4) What needs to be considered for evaluating plans for mass-transportation projects?

Why the issue is important

- Transportation infrastructure is fundamental to the way communities and economies function by ensuring that people can reach necessary destinations including jobs, schools and grocery stores.
- Public transit offers significant health benefits including reductions in motor vehicle crashes, air pollution and physical inactivity, as well as ensuring greater equity and inclusion for those unable to drive or without regular access to a personal vehicle.
- Large-scale infrastructure projects, such as building new trains or subways, offer significant benefits including quicker commuting times, better connectivity, and a stimulation to the local economy, however they may also result in potential disadvantages to the surrounding communities, including noise pollution and housing displacement.

What we found

- We found 14 documents that were relevant to one or more of the questions: one overview of 117 systematic reviews, seven systematic reviews, one scoping review, one report by a working group of the International Tunnelling Association, one web-based resource with an overview of evidence, and three primary studies that provided insights not covered in the other sources.
- From these documents we found very little evidence about the trade-offs of above-ground versus below-ground mass-transit systems, but several documents noted that rigorous evaluations of infrastructure projects are critical to properly estimate the impacts on the built environment in communities.
- A review from the What Works Centre on Local Economic Growth notes that evaluations of transit projects are often flawed as they fail to establish a valid counterfactual (i.e., what would have happened to an area if the project hadn't happened) or a valid alternative (i.e., what would happen if a different option was pursued).
- As a result, there is a need for robust health-impact assessments that focus on a meaningful engagement process with residents, businesses and other stakeholders to identify, analyze and incorporate their values and preferences into transit-planning processes that will affect the communities they live and work in for decades to come.
- Many different health-impact assessment tools have been developed for assessing public-transit projects.
 - A recent scoping review identified 26 tools that had been used to assess public-transportation and land-use projects.
 - However, most of these tools relied solely on qualitative measurements.
 - Researchers conducting the scoping review suggested that adding relevant quantitative methods greatly improves the estimates of impacts over the long term, and examples of such tools include the Integrated Transport and Health Impact Model, and the Healthy Development Measurement Tool.

QUESTIONS

In relation to planning mass-transit project, this rapid synthesis addresses four inter-related questions.

- 1) What is the importance of transit to communities and large cities?
- 2) What are important health, social and economic trade-offs of above-ground versus below-ground mass-transit systems?
- 3) What is the role of mass transit as part of multi-purpose-built environments and impacts on community health and prosperity?
- 4) What needs to be considered for evaluating plans for mass-transportation projects?

WHY THE ISSUE IS IMPORTANT

Transportation infrastructure is fundamental to the way communities and economies function by ensuring that people can reach necessary destinations including jobs, schools, and grocery stores. Public transportation, in particular, allows community members to do this affordably and reliably. In 2016, 12.4% of Canadians, or 4.5 million people, relied on public transit to get to work, most of which took place in major cities such as Toronto, Vancouver and Montreal.(1)

Public transit offers significant health benefits including reductions in motor vehicle crashes, air pollution and physical inactivity.(2) Importantly, it also plays a key role in ensuring equity to those who are unable to drive or walk to destinations, including those without access to personal vehicles, children and young adults, individuals with disabilities, and older adults.(2) Therefore, mass transit not only provides transportation resources to these community members but helps to ensure their inclusion and participation in broader urban life.(2)

While public transportation is critical to vibrant communities, the location of infrastructure for it can be contentious for the surrounding neighbourhoods. Large-scale infrastructure projects, such as building new trains or subways, offer significant benefits including quicker commuting times, better connectivity, and a stimulation to the local economy. However, they may also result in the displacement of housing, noise pollution and changes to surrounding property prices. The balance between the costs and benefits of these types of infrastructure projects lie in the details of their planning. In this rapid synthesis, we examine evidence related to: the importance of transit to communities and large cities; the health, social and economic trade-offs of above-ground versus below-ground mass-transit systems; the importance of multi-purpose-built environments for community health and prosperity; and methods to evaluate transportation projects.

Box 1: Background to the rapid synthesis

This rapid synthesis mobilizes both global and local research evidence about a question submitted to the Forum's Rapid Response program. Whenever possible, the rapid synthesis summarizes research evidence drawn from systematic reviews of the research literature and occasionally from single research studies. A systematic review is a summary of studies addressing a clearly formulated question that uses systematic and explicit methods to identify, select and appraise research studies, and to synthesize data from the included studies. The rapid synthesis does not contain recommendations, which would have required the authors to make judgments based on their personal values and preferences.

Rapid syntheses can be requested in a three-, 10-, 30-, 60- or 90-business-day timeframe. An overview of what can be provided and what cannot be provided in each of these timelines is provided on the McMaster Health Forum's Rapid Response program webpage (www.mcmasterforum.org/find-evidence/rapid-response).

This rapid synthesis was prepared over a three-business-day timeframe and involved three steps:

- 1) submission of a question from a policymaker or stakeholder;
- 2) identifying, selecting, appraising and synthesizing relevant research evidence about the question; and
- 3) drafting the rapid synthesis in such a way as to present concisely and in accessible language the research evidence.

WHAT WE FOUND

We found 14 documents that were relevant to one or more of the questions: one overview of 117 systematic reviews;(3) seven systematic reviews;(4-10) one scoping review;(11) one report by a working group of the International Tunnelling Association;(12) one web-based resource with an overview of evidence;(2) and three primary studies (13-15) that provided insights not covered in the other sources.

We summarize the key findings from the literature we identified below and in Table 1. Overall, while we found little evidence about the trade-offs of above-ground versus below-ground mass-transit systems, several of the included documents emphasized that rigorous evaluations of infrastructure projects are critical to properly estimate the impacts on the built environment in communities. For example, a review from the What Works Centre on Local Economic Growth notes that evaluations of transit projects are often flawed as they fail to establish a valid counterfactual (i.e., what would have happened to an area if the project hadn't happened) or a valid alternative (i.e., what would happen if we pursue a different option).(6) This points to the need for robust health-impact assessments that focus on a meaningful engagement process with residents, businesses and other stakeholders to identify, analyze and incorporate their values and preferences into transit-planning processes that will affect the communities they live and work in for decades to come.

Importance of transit to communities and large cities

For this question, we found four systematic reviews, two studies and a web-based resource from the U.S. Centers for Disease Prevention and Control (CDC) that provides an overview of evidence of the health impact and cost-effectiveness of public-transportation systems.(2) The systematic reviews highlight that transit-expansion projects typically result in increased property values, physical activity, better cardiovascular outcomes in the general population, a lower fear of social isolation, and improved mental health.

One of the reviews assessed 86 public transport systems and also found:

- that system designs that create segregations in urban spaces make it difficult to create attractive urban spaces around stations “due to the significant intervention in the urban space as compared to the establishment of, for instance, subsurface metro systems”;
- decreasing real-estate prices in the immediate area of designs such as bus rapid-transit stations as the benefits from the increased mobility did not compensate for the negative externalities such as noise and barrier effects; and
- that it is essential to “consider how to obtain large benefits in the form of travel time and improved accessibility, while at the same time creating an attractive and accessible environment around the stations.”(4)

In addition, the following are key points from the evidence included in the overview of the impact and cost-effectiveness of public-transportation systems:

Box 2: Identification, selection and synthesis of research evidence

We identified research evidence (systematic reviews and primary studies) by searching databases in December 2020 that index systematic reviews ([HealthEvidence](#), [Health Systems Evidence](#), and [Social Systems Evidence](#)), databases that index reviews and primary studies (EBSCO and ProQuest), and additional sources that we hand searched for relevant content (What Works Centre for Local Economic Growth which includes a section on public transportation and the OECD website). For the databases that we searched, we used combinations of search terms for public transit (e.g., public transit and mass transit) and rail-based transit (e.g., train and rail). We also used specific search filters for each database either for the overall topic (e.g., the transportation filter on Social Systems Evidence) or for specific questions (e.g., the intervention filter for ‘built environment’ on HealthEvidence for the fourth question addressed in this rapid synthesis).

The results from the searches were assessed by one reviewer for inclusion. A document was included if it fit within the scope of the questions posed for the rapid synthesis.

- public transportation systems enhance travel-related safety (e.g., public transportation has been found to account for less than 1% of transportation-related fatalities as compared to 75% associated with private passenger vehicles, and fatality rates per billion passenger miles travelled was found to be approximately seven times higher for drivers or passengers in car or light truck (7.28) compared to buses (0.11), urban mass-transit rail trains (0.24) and commuter rails (0.43));
- transit expansion is associated with reduced vehicle miles travelled (and their associated emissions) and pollution from public transportation produces significantly less harmful pollution than private vehicles;
- public transportation use is associated with eight to 33 additional minutes of walking per day in overall daily physical activity (particularly among those with previously low activity levels);
- per capita annual health benefits of improving a typical North American public-transit service to high-quality (i.e., fast, convenient and comfortable) urban rail or bus rapid-transit service has been found to be \$355, and if improvements were made in a way that is walkable with mixed-used development close to stations, that amount increases to \$541; and
- an increase in the proportion of households located in transit-oriented developments in cities of approximately one million people from 10% to 20% would result in approximately \$71 million of total annual health benefits, and an increase from 10% to 40% would result in more than \$216 million of total annual health benefits.(2)

Health, social and economic trade-offs of above-ground versus below-ground mass transit systems

There is a significant gap in the literature addressing these decisions. We found one report from 2004 by the International Tunnelling Association (ITA) which discusses the health, social and economic trade-offs of above-ground and below-ground transit systems. The report notes the importance of context in making above-ground versus below-ground decisions, and lists the following as important considerations: capital cost; visual/esthetic implications; ridership; dividing the community; development potential; construction impacts; difficulty obtaining right-of-way; vibration; operating costs; air pollution; noise pollution; and risk to cost, schedule or quality.

Importance of multi-purpose built environment for community health and prosperity

We found four systematic reviews and one primary study that focused on the importance of multi-purpose built environment for community health and prosperity. Each of the four systematic reviews highlighted the importance of urban green space on the health and well-being of surrounding communities. Three of the reviews found that increased use of and exposure to urban green space was associated with increases in physical activity, children's attention span, mental health and mood, as well as reductions in heart disease. One primary study also found that the presence of parks in neighbourhoods was linked to positive factors including greater neighbourhood social connection, nature engagement, exercise opportunities and lower neighbourhood disorder.

Evaluating transportation projects

We found one systematic review and a recent scoping review on methods to evaluate transportation projects. One systematic review used the findings to develop a framework to evaluate the sustainability of transportation projects in contained urban transit systems. The scoping review examined the use of health-impact assessments for transportation projects and found that the involvement of transportation officials and public health in evaluating the impacts of a new transit initiative led to greater influence in decision-making. Specifically, the scoping review identified 26 tools that had been used to assess public transportation and land-use projects. However, most of these tools relied solely on qualitative measurements.(11) Researchers conducting the scoping review suggested that adding relevant quantitative methods greatly improves the estimates of impacts over the long term. Examples of such tools include: 1) the Integrated Transport and Health Impact Model (ITHIM); and 2) Healthy Development Measurement Tool (HDMT).

Table 1: Overview of documents found and their key findings

Domains	Key findings
Importance of transit to communities and large cities	<ul style="list-style-type: none"> • A review of 86 public-transport systems found significant positive impacts on property values from investments in public-transport systems regardless of the type of transit (bus, light rail or heavy rail), and also found: <ul style="list-style-type: none"> ○ System designs that create segregations in urban spaces make it difficult to create attractive urban spaces around stations “due to the significant intervention in the urban space as compared to the establishment of, for instance, subsurface metro systems” ○ Decreasing real-estate prices in the immediate area of designs such as bus rapid-transit stations as the benefits from the increased mobility did not compensate for the negative externalities such as noise and barrier effects ○ It is essential to “consider how to obtain large benefits in the form of travel time and improved accessibility, while at the same time creating an attractive and accessible environment around the stations” (4) • Each of the five studies in a recent and high-quality systematic review found that after completion of new transit infrastructure, there may be declines in total physical activity, but transport-related physical activity may increase, and there may be increases in physical activities among specific groups (e.g., those who were least active before transit completion, those closest to a station and among females with low education) (5) • Two studies included in a systematic review found that providing efficient public transportation was associated with higher physical activity, better cardiovascular outcomes in the general population, a lower fear of social isolation, and improved mental health (6) • Five of seven studies included in the same systematic review found positive effects on residential property prices with proximity to rail stations, but the two remaining studies found no effect of proximity (6) <ul style="list-style-type: none"> ○ Other economic benefits of rail transportation are not well established in the literature • An assessment of 14 major transit expansions in cities around the world over a 30-year time span points to important “increases (in) the supply of transit-oriented communities where people can live, commute and shop while using the private auto less frequently” (13) • The study also found that the local impacts of new transit differ significantly with some cities experiencing great gentrification (e.g., Boston and Washington D.C.) while others (e.g., Los Angeles and Portland) have not experience such gentrification (based on home-prices dynamics and the number of college graduates) (13) • A survey of 51 residents before and after a new light rail stop was constructed in their Salt Lake City neighbourhood found that residents: <ul style="list-style-type: none"> ○ Had accurately predicted most of the changes they subsequently experienced ○ Indicated there were increases in neighbourhood economic values (e.g., taxes and housing costs) after the completion of the project ○ Reported perceived enhancements of neighbourhood reputation and sense of community ○ Reported that post-construction surprises were positive, including more sense of community, less crime, and more child and pedestrian safety than anticipated (14)
Health, social and economic	<ul style="list-style-type: none"> • An older report focused on making above-ground versus elevated versus below-ground transit decisions stressed the importance of context in making these

Domains	Key findings
trade-offs of above-ground versus below-ground mass-transit systems	<p>decisions, but also noted that consideration of direct and indirect benefits and costs is critical, particularly over the long term</p> <ul style="list-style-type: none"> • The same report notes outside-of-the-city advantages to at-grade or elevated alignment offers the ability to construct longer transit systems at the same capital cost or a lower investment cost compared to underground, however, within cities, problems of elevated alignment include availability of sufficient right-of-way, and the long-term environmental and real-estate impacts • Moreover, the report outlines that considerations for whether to place a transit project above or below ground include: <ul style="list-style-type: none"> ○ Capital cost ○ Visual/esthetic considerations ○ Ridership ○ Dividing the community ○ Development potential ○ Construction impacts ○ Difficulty obtaining right-of-way ○ Vibration ○ Operating costs ○ Air pollution ○ Noise pollution ○ Risk to cost, schedule or quality (12)
Importance of multi-purpose-built environment for community health and prosperity	<ul style="list-style-type: none"> • Three quantitative studies included in a systematic review from an overview of systematic reviews point to how the built environment can have an impact on the health of the surrounding population as they found that exposure to excessive noise was linked to lower mental health outcomes and higher risk of ischemic heart disease in the surrounding communities (3) • The same overview of systematic reviews found that access to and engagement with the natural environment (such as through parks and green space) was associated with numerous positive physical and mental health outcomes (3) • The overview of systematic reviews also highlighted four planning principles to promote health in the built and natural environment: reduce exposure to environmental hazards; provide active travel infrastructure (e.g. increased infrastructure for walking and cycling); encourage the use of public transit; and enable mobility for all ages and activities (e.g., access to recreational space and active travel to work and school) (3) • One systematic review reported supportive findings on the health, social and environmental benefits of urban green space to surrounding communities (7) • Studies included in one systematic review found that higher green space exposure during childhood was associated with increased levels of physical activity and a lower risk of obesity, as well as a reduction in neurodevelopmental issues such as inattentiveness (9) • Another systematic review focused on urban green space and health, found a consistent negative association between access to urban green space and mortality, heart rate, and violence, as well as a positive association with attention, mood and physical activity (8) • A primary study found that community residents had greater life satisfaction in more walkable neighbourhoods and neighbourhoods with parks (15)

Domains	Key findings
	<ul style="list-style-type: none"> • The same study found that satisfaction with local parks was also linked to other positive factors including greater neighbourhood social connection, nature engagement, exercise opportunities and lower neighbourhood disorder
Evaluating transportation projects	<ul style="list-style-type: none"> • A framework developed out of a systematic review on sustainable transportation projects in micro-transit systems (i.e., contained transit systems in urban areas) includes 12 evaluation categories and 188 variables to consider, each with a suggested weight attached to the category, indicators and variables (10) • The same review identified that categories to consider during evaluations include: <ul style="list-style-type: none"> ○ Pollution ○ Transport resource consumption ○ Ecological and geographical damage/impacts ○ Initiatives for environmental protection ○ Anticipated service quality ○ Accessibility and availability ○ Safety and security ○ Government and community involvement ○ Mobility ○ Financial perspective (cost) ○ Socio-economic perspective ○ Productivity of the system • Health-impact assessments (HIA) provide a multidisciplinary approach to evaluate the potential impacts of a project on community health and the distribution of those effects within the community <ul style="list-style-type: none"> ○ A scoping review of HIAs for transportation found that the involvement of transportation officials in the HIA process and of public health in the evaluation of transportation initiatives led to positive impact on the HIA influencing decisions (11) ○ The same review provides an overview of HIA tools that have been developed specifically for evaluating transportation projects

REFERENCES

1. Statistics Canada. 2016 Census topic: Journey to work. Statistics Canada; 2019. <https://www12.statcan.gc.ca/census-recensement/2016/rt-td/jtw-ddt-eng.cfm> (accessed 2021-03-01).
2. Centers for Disease Control and Prevention - Office of the Associate Director for Policy and Strategy. Public transportation system: Introduction or expansion. Centers for Disease Control and Prevention; 2018. <https://www.cdc.gov/policy/hst/hi5/publictransportation/index.html> (accessed 2021-03-01).
3. Bird EL, Ige JO, Pilkington P, Pinto A, Petrokofsky C, Burgess-Allen J. Built and natural environment planning principles for promoting health: An umbrella review. *BMC Public Health* 2018; 18(1): 930.
4. Ingvardson JB, Nielsen OA. Effects of new bus and rail rapid transit systems: An international review. *Transport Reviews* 2018; 38(1): 96-116.
5. Hirsch JA, DeVries DN, Brauer M, Frank LD, Winters M. Impact of new rapid transit on physical activity: A meta-analysis. *Preventive Medicine Reports* 2018; 10: 184-190.
6. What Works Centre for Local Economic Growth. Evidence Review 7: Transport. London, United Kingdom: What Works Centre for Local Economic Growth; 2015.
7. Hunter RF, Cleland C, Cleary A, et al. Environmental, health, wellbeing, social and equity effects of urban green space interventions: A meta-narrative evidence synthesis. *Environment International* 2019; 130: 104923.
8. Kondo MC, Fluehr JM, McKeon T, Branas CC. Urban green space and its impact on human health. *International Journal of Environmental Research and Public Health* 2018; 15(3): 445.
9. Islam MI, Johnson J, Sly PD. Green space and early childhood development: A systematic review. *Reviews on Environmental Health* 2020; 35(2): 189-200.
10. Buenk R, Grobbelaar SS, Meyer I. A framework for the sustainability assessment of (micro)transit systems. *Sustainability* 2019; 11(21): 5929.
11. Waheed F, Ferguson GM, Ollson CA, MacLellan JI, McCallum LC, Cole DC. Health impact assessment of transportation projects, plans and policies: A scoping review. *Environmental Impact Assessment Review* 2018; 71: 17-25.
12. Association IT. Underground or aboveground? Making the choice for urban mass transit systems: A report by the International Tunnelling Association. *Tunnelling and Underground Space Technology* 2004; 19(1): 3-28.
13. Kahn ME. Gentrification trends in new transit-oriented communities: Evidence from 14 Cities that expanded and built rail transit systems. *Real Estate Economics* 2007; 35(2): 155-182.
14. Brown BB, Werner CM. The residents' benefits and concerns before and after a new rail stop: Do residents get what they expect? *Environment and Behavior* 2011; 43(6): 789-806.
15. Pfeiffer D, Ehlenz MM, Andrade R, Cloutier S, Larson KL. Do neighborhood walkability, transit, and parks relate to residents' life satisfaction? *Journal of the American Planning Association* 2020; 86(2): 171-187.



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>> Contact us

1280 Main St. West, MML-417
Hamilton, ON, Canada L8S 4L6
+1.905.525.9140 x 22121
forum@mcmaster.ca

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