Build it and They Will Come:
Investigating the Effects of COVID-19
on the Operations of and Use of the Montreal Metro

by

Zachary Beresin

A Thesis Submitted in Partial Fulfillment of the Requirements for the
Degree of B.A. Joint Honors in Geography and International Development Studies

Department of Geography
McGill University
Montréal (Québec) Canada

April 2022

ACKNOWLEDGEMENTS

I would like to thank my supervisor, Dr. Kevin Manaugh, and my reader, Dr. Sarah Turner, for working with me on this project. Kevin's invaluable advice shaped this project in every step along the way. Sarah's guidance throughout this project, and the entirety of my studies in the department, has been deeply influential. To Kevin and Sarah, I cannot express enough gratitude for your time and commitment to support my ambitions. It was a privilege to work with you both.

Thank you to Michelle Maillet for pushing me to pursue the honours program. I gladly speak for many of my peers in the department in stating that your efforts are sincerely appreciated and do not go unnoticed.

This project would not have been possible without the endless support of my family and friends. A special thank you to my dear friend, Henry Carter, for without your passion for learning I would not be where I am today.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

The majority of transportation resilience literature has documented resilience efforts to natural shocks and stressors, which often focuses on how damage to the physical infrastructure of transport networks impedes function and use. In this study, I aim to address a gap in the literature centered around the impact of the COVID-19 pandemic on the operations of and use of the Montreal Metro. An evaluation of resilience planning initiatives and riders' risk perceptions underlines the mixed-methods approach that I have employed. In tandem, these two components of analysis support a well-rounded assessment of the role which the Montreal Metro plays in the city's mobility network in the context of the COVID-19 pandemic. My results identified that the City of Montreal faces a looming financial crossroads, threatening their plans for long term resilience efforts which thus far have proven critical in promoting confident ridership.

CHAPTER 1: INTRODUCTION

The outbreak of COVID-19 had a profound negative impact on the ridership of the Montreal Metro, the city's underground rapid transport network. Crowded, enclosed areas – characteristics of spaces which people have been instructed by public health officials to stay away from – Metro stations and trains have been regarded as a primary area where fear of the spread of COVID-19 persists. Spanning four lines and 68 stations, the Metro is an integral component in Montreal's mobility network. Prior to the pandemic, during the morning rush hour, 75% of trips to downtown Montreal were made by public transit (STM, pers. comm., November 24, 2021). Once a bustling service, the Montreal Metro has become a symbol of the disruption of urban life during the pandemic.

The Société de transport de Montréal (STM), the agency responsible for operating the Metro, has made a concerted effort to counteract declining pandemic ridership trends based on transportation resilience frameworks. In collaboration with the regional public health department (Direction régionale de Santé publique de Montréal) and the City of Montreal, the STM was tasked to efficiently and effectively promote a resilient service which addressed the developing concerns of riders. As the pandemic continues it is unclear if or when ridership will return to average pre-pandemic levels. This research is intended to assess the STM's resilience efforts and the public perception of personal safety traveling on the Metro to identify the effects of COVID-19 on Metro ridership.

1.1 Research Questions

The aim of this project is to understand how the COVID-19 pandemic has affected the day-to-day operations of the Montreal Metro. This research is intended to assess the public perception of personal safety traveling on the Metro in order to determine if COVID-19 related concerns are a factor contributing to decreased ridership. Through a mixed-methods approach, I aspire to advance the existing scholarship on factors contributing to decreased ridership of metro networks and the ongoing process to reverse these trends, in an effort to understand how COVID-19 has altered the operations of and use of the Montreal Metro.

I propose three primary research questions:

1. What strategies did the STM take to encourage use of the Metro to counteract the negative impact COVID-19 has had on ridership?
2. Was the public perception of safety on the Metro impacted by COVID-19?
3. What are the long-term costs and implications of decreased Metro ridership on the operations of the STM?

1.2 Overview of Thesis Structure

In Chapter 2, I review foundational literature on two main topics: transportation resilience and the role of risk perception in decision making. Transportation resilience literature includes common approaches for preparing for, responding to, and recovering from threats to the operations of public transportation networks, and recent applications by scholars to nontraditional threats. Then, I examine risk perception, including the Theory of Planned Behavior, to introduce the factors involved in the decision-making process of riders during the pandemic. In Chapter 3, I provide the methodology designed for this project, including the design of surveys and interviews carried out with Montrealers, and the design of an interview with an STM Corporate Advisor. In Chapter 4, I analyze the STM's calculated approach to pandemic resilience planning. This includes an overview of service offerings, new measures for customer and employee safety, and a short review of the STM's financial standing. In Chapter 5, I turn to the perspectives of Montrealers on their use of the Metro and pandemic mobility patterns, based on the survey and interview responses from research participants recruited for this project. Survey data and interview excerpts are analyzed in tandem to evaluate the public perception of the STM's pandemic operations. Finally, in Chapter 6, I present conclusions on the current state of the Montreal Metro, and its role in urban mobility and sustainability within the context of the effects of COVID-19 in Montreal.

CHAPTER 2: LITERATURE REVIEW

Transportation resilience is the ability of a system to recover from shocks or stressors to physical infrastructure and operations (Weilant et al., 2019, 5). Resilience has "increasingly been seen in the literature" on public transportation networks, commonly included alongside measures of robustness, reliability, survivability, and flexibility (Zhou et al., 2019, 4262). A two-pronged approach to understanding transportation resilience planning involves: (1) interviewing stakeholders to better understand the role that transportation resilience plays in practice; and (2) reviewing published literature and metrics on transport resilience (Weilant et al., 2019, iii). The latter is the focus of this chapter, examining literature on both common and uncommon threats to understand the STM's approach to responding to the outbreak of COVID-19.

2.1 Transportation Resilience Planning

2.1.1 Resilience Frameworks

Broadly, the three phases of transportation resilience are: (1) preparing for; (2) responding to; and (3) recovering from a shock or stressor (Atun, 2014, 67). In all three stages, the health and safety of riders and employees is prioritized to bring about a smooth, confident return to ridership. A rapid, coordinated approach requires close collaboration between key actors. The outcome of resilience planning is determined by the ability of a transit agency to implement initiatives that reduce the time necessary to recover to a state of 'normal functioning', which may be defined differently from pre-event functioning (Weilant et al., 2019).

Rose (2007) separates resilience into two categories: static and dynamic. This is a distinction which will serve as the foundation of this paper for understanding the unique circumstances of COVID-19 resilience efforts. Static resilience is the capability of a system to maintain function (Rose, 2008, 384). This concept is used in transportation resilience literature which focuses on addressing repairs to damaged infrastructure caused by common shocks and stressors such as natural disasters and terrorist attacks (see section 2.1.2). Dynamic resilience is the capability of a system to recover rapidly from a severe shock to achieve a desired state (Rose, 2007, 384). Static resilience is largely a tool for understanding supply-side considerations, while dynamic resilience pertains to demand-side considerations (Cox et al., 2010, 309). This typology

is critical to analyze resilience planning in circumstances where the consumer demands new or adapted measures to meet their safety and security requirements in the post-event context. While static resilience efforts ensure that there is a functioning transit system in place, dynamic resilience efforts are designed to encourage riders to choose public transportation over alternative methods of travel long term (Cox et al., 2010). As a shock to the system COVID-19 did not threaten the physical infrastructure of the Metro network, but did threaten the confidence of riders in their own safety. Despite no damage having been done to the physical infrastructure, dynamic resilience efforts pose a significant financial cost given the sharp drop in revenue from low ridership combined with costly measures adopted to promote confident riding; explored in detail in Chapter 4. The cost of dynamic resilience efforts, as compared to necessary repairs to infrastructure for static resilience, is difficult for transit agencies to justify long term when ridership does not return swiftly.

In application of Rose's (2007) economic model, it is critical to take into account that the relationship between public transit service providers and riders is more complex than just supply and demand. STM CEO Luc Tremblay stated that in response planning to COVID-19 "supply is not being determined by demand, but by our moral obligation to make sure that we and our 11,000 employees are providing our customers with the safest service possible, and rightly so" (STM, 2020d: online). The continued functioning of public transit facilitates the social, economic, and environmental systems of a city to operate in an undisrupted fashion. Zhou et al. (2019, 4262) noted:

> Transportation networks serve as lifelines that provide access to impacted areas to support emergency response and long-term recovery operations after a disaster, [therefore] the stable functionality of transportation networks means a lot from both economic and welfare perspectives.

Applying Rose's (2007) framework to transportation resilience studies facilitates an introduction to the dynamics of the relationship between transit planners and riders in the aftermath of a shock or stressor, but must not limit analysis outside of this paradigm. Resilience planning is not a series of direct negotiations with riders, but rather a coordination of strategies by transit agencies to address riders' anticipated safety concerns. To support those dependent on

public transportation during COVID-19 – including essential workers and those who use transit to access medical services – resilience efforts cannot be simplified to that of a free market transaction (Weilant et al., 2019, 17). Transportation resilience planning is geared towards prioritizing safety, efficiency, and affordability for riders in order to encourage a strong return to form, city-wide (Litman, 2020, 7). In this exchange, the seller must operate on the buyer's terms. Dynamic resilience remains a keen area of interest to investigate through public surveys and interviews to assess whether riders believe transportation agencies and their city have in fact remediated negative impact from the pandemic by achieving a desired state of resilience.

2.1.2 Common threats

Cox et al. (2010, 307) define the concept of resilience as one that has been "traditionally explored in the context of natural disasters," — which they extended to explore the effect of terrorist attacks on the operations and use of public transportation networks (see section 2.2.2). Extreme weather often threatens the physical infrastructure of metro networks by causing damage that impedes the smooth functioning of trains and stations. A focus on natural disasters facilitates resilience planning that includes pre-event planning, which does not translate to unexpected shocks such as terrorist attacks, or the outbreak of a pandemic. Many resilience frameworks specify a focus on preparation, absorption, or hazard mitigation phases, all largely encompassing the same techniques under different labels (Atun, 2014; Weilant et al., 2019; Cox et al., 2010).

Authors have begun incorporating considerations for other stressors when it comes to the preparation phase of resilience planning (Weilant et al., 2019, 23). In limited quantities, some transportation resilience literature has focused on human hazards, such as congestion and population growth (Weilant et al., 2019, 23). Still, neither natural nor human-made stressors have explicitly considered the potential consequences of a pandemic. Even so called "future challenges" – long-term hypothetical threats to public transportation such as cyberattacks – do not touch upon hygienic concerns associated with public transportation (Weilant et al., 2019, 57). Just one year before the outbreak of COVID-19, Weilant et al. (2019, ix) recommended that transportation planners should expand the objectives and scope of alternative resilience

frameworks to include shocks and stresses that are not directly tied to climate change to promote resilience.

2.2 Extending the approach

2.2.1 Gaps in planning

COVID-19 poses a unique threat to the operations of transport, in that there is no foundational background in pandemic transportation resilience planning for cities to draw from. Transit agencies were pushed to respond in real time, making decisions that will have lasting impacts on their service offerings. In 2020, the COVID-19 pandemic brought about the steepest monthly declines in Montreal Metro ridership in history, a trend which the STM responded to promptly by maintaining regular train service and introducing new comprehensive safety measures (STM, pers. comm., November 24, 2021)

Evaluating the STM's coordination with public health officials in response to COVID-19 confirms Atun's (2014, 72) notion that the largest obstacle to resilience planning likely occurs as a result of connections that had never been established between public transit and public health. Resilience literature notes that public transit decision making is typically reductionist, meaning that transportation agencies and health agencies often neglect collaboration on policy (Litman, 2003, 103). "The main mistake done frequently is dealing with complex systems as if they were just complicated and separated from their environment" (Atun, 2014, 72). The rise of COVID-19 has prompted a reversal of this trend, sparking the necessity for close collaboration between these sectors in a short time to develop initiatives that prioritize the health and safety of riders and employees. These connections have typically only been discussed prior to the pandemic to reduce air pollution and increase connectivity of public transport with active transportation networks (Besser and Dannenberg, 2005). The pandemic has proven that transportation authorities, city officials, and public health officials can work together to integrate health objectives in transportation planning to effectively boost public confidence in the safe use of public transportation.

2.2.2 Lessons from London

The July 7th, 2005 bombings of the London Underground changed the way that scholars approach transportation resilience. Cox et al. (2010) address the gap in literature between transportation resilience efforts and non-traditional shocks to transportation systems. The article keys in on resilience to 'black swan' events – low probability, high consequence, and unpredictable events. Cities have long been unprepared for pandemic resilience planning, which has made COVID-19 response planning a challenging process. In comparison to the traditional resilience approaches, the approach employed by Transport for London (TFL) in response to the 2005 bombings of the London Underground presents a framework for promoting dynamic resilience for non-traditional threats. Figure 2.1 applies the concepts of static and dynamic resilience to that of the London bombings (Cox et al., 2010, 313).

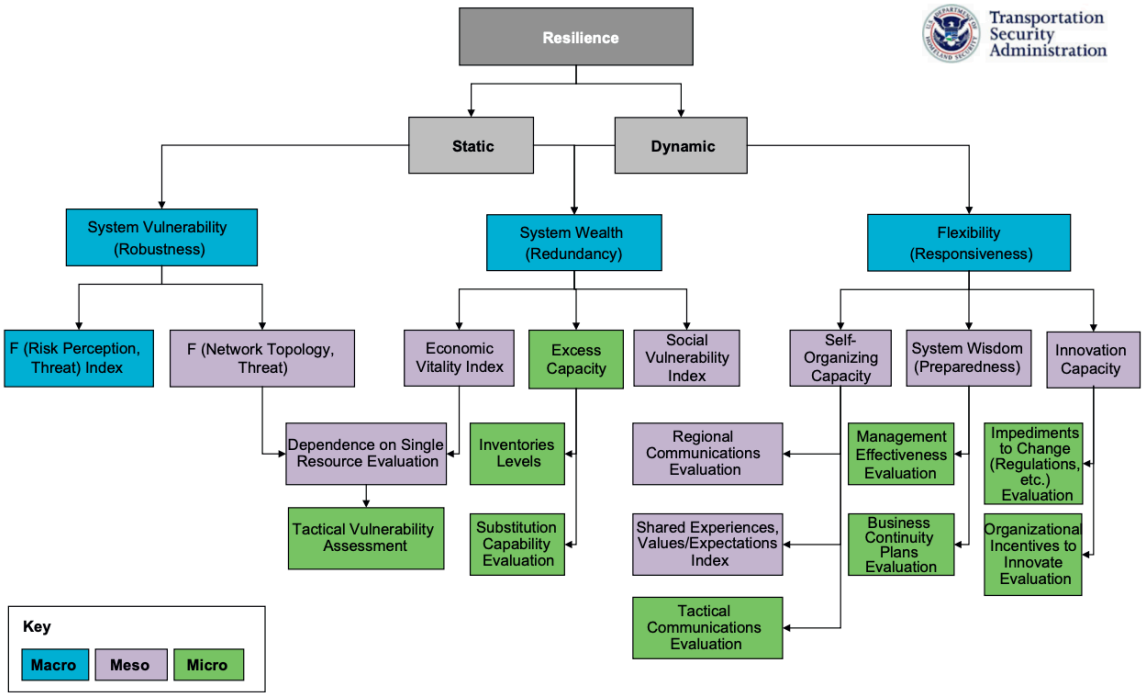

Figure 2.1: London Resilience Framework

(Source: Cox et al., 2010, 313)

Indices for measuring resilience in unexpected shocks or stressors can be separated by various levels of analysis. In this figure, the risk perception index is highlighted under static resilience. In analysis of COVID-19, risk perception may fit better under dynamic resilience, given the lack of damage to the physical infrastructure of the system. Nevertheless, this aspect of resilience is especially important in studying how the effects of non-traditional threats shift riders' mode decision-making, which is addressed in section 2.3.

The TFL and City of London invested heavily into shaping risk perception by encouraging riders of the safety of their transport network. Just days after the July 7th attacks, London Mayor Ken Livingstone rode the network himself to commute, as was his usual habit (Litman, 2010, 1). The STM has similarly turned to communication campaigns addressed towards the safety of their network, and the ways in which riders can share the responsibility to promote their safety, explored in Chapter 4.

Over 15 years later, the TFL's approach to calming fears of transit ridership is an exemplary resilience plan to extend to other shocks and stressors. The scale of the bombings, over five times deadlier than the next largest transit attack (Tokyo 1995), meant that decision-makers were presented with a situation that was distinct from those covered in existing frameworks for transportation resilience. While no threat to transportation is predictable, both the 2005 London bombings and the outbreak of the COVID-19 pandemic were very different than any other threat covered in transportation resilience literature at the time of their occurrence. Much like COVID-19, the London bombings resulted in a distinct need for dynamic resilience planning designed to quell the fears of riders. Even more challenging, the bombings caused significant physical damage to the London Underground tunnels, adding an additional layer of necessary static resilience planning (Urlainis et al., 2014, 532).

The London bombings serve as a catalyst to expanding transportation literature studies, building on the foundation of literature from which unpredictable shocks and stressors to public transportation can be approached. In the aftermath of low probability, high risk shocks to public transportation systems, dynamic resilience efforts are invested in measures that promote positive safety and security levels for riders returning to an altered environment (Litman, 2020, 9). The response of TFL to the London bombings demonstrates the high level of effort required to

achieve this. In addition, one of the most important takeaways from literature on the events in London is the incorporation of riders' decision making in the city's approach to resilience planning, which is explored in the next section of this chapter.

2.3 Risk perception

2.3.1 Value of perception-based framework

While Chen and Chao (2011, 129) assert that "past behavior is the best predictor of future behavior", it is the goal of this research to discover whether the determinants of transportation mode choice have shifted due to COVID-19. Chen and Chao (2011, 128) highlight a gap in their own research: that psychological factors which "influence an individual's decision-making in [regards to public transit use]... still remain relatively unclear". When habits change, attitudes towards public transit will change, but the extent and duration of this change remain questions to be addressed. Using this framework, analysis of the public perception concerning the safety of riding the Montreal Metro during COVID-19 can be undertaken.

Literature on the 2005 events in London suggests that "individuals may have altered their risk perceptions of travel on the London Underground as a result" of perceived threats (Prager et al., 2011, 782). Cox et al. (2010, 310) explore the value of understanding risk perception in a transportation resilience context:

> Risk perception is a fundamental ingredient in any formulation of resilience. Often, it is possible to clearly see the effects of risk perception in resilience oriented substitution behavior in the aftermath of some sort of disaster or attack. As a result, there is significant utility for decision makers to look at both qualitative risk perception criteria as predictive indications of how a system and its constituents will respond, as well substitution-behavior metrics as outcome indications of how a system will respond.

Persistent fear of public transport presents an obstacle to long-term resilience objectives. Transit agencies work to counter the effects of the psychological dread risk effect – excessive fear of low probability, high-profile events such as… new diseases" – by promoting confidence in riders within the new context. As part of their risk equation calculations, Cox et al. emphasize "the role of public behavioral response in resilience" (Cox et al., 2010, 307).

2.3.2 Theory of Planned Behavior

The Theory of Planned Behavior (TPB) has often been used to predict how public transportation will be used based on prior data, as evidenced in Heath and Gifford (2002). For many reasons, TPB analysis is beneficial for transit officials promoting the increased usage of public transit, moving away from cars which pollute the environment at extreme rates in comparison. To determine the cause for increased ridership, studies of behavior yield data that helps transit officials to understand which policies or plans are effective and which are not. Behavior often plays into social norms, and measures that adapt well to social norms do not cause alarm within the public. This leads to increased positive attitudes towards taking public transit. This framework has proven useful for circumstances that are consistent surrounding public transit planning. Applying this framework to the circumstances of COVID-19 will aid in understanding how people process the risks of riding the Metro at different points during the pandemic.

Elements of TPB analysis facilitate the creation of models that explain individuals' perceptions of public transit. Three main determinants of behavioral intentions are identified: (1) behavioral; (2) normative; and (3) control beliefs. These three lines of thinking affect how travel mode choice is determined, extending the discourse on contextual factors, an individual's abilities and constraints, and various psychological factors. Surveying people about their ridership choices in the COVID-19 context tests this theory, yielding conclusions that provide clarity to Chen and Chao's uncertainty about the influence of psychological factors on public transit ridership. The research laid out by Chen and Chao (2011) opens the door for studies on individual perceptions and behaviors in discussion of how one makes decisions about using public transit.

CHAPTER 3: METHODOLOGY

In this chapter, I detail the methodology I developed to survey and interview stakeholders "to better understand the role that transportation resilience plays in practice," to satisfy the first prong of Weilant et al.'s (2019, iii) approach. I also outline the portion of this project dedicated to archival analysis, assessing press releases, reports, and other materials published by the STM pertinent to COVID-19 resilience planning.

To obtain permission to conduct surveys and interviews, an application for ethics approval was submitted to the McGill University Research Ethics Board (REB) on June 25th, 2021. Because of the uncertainty of COVID-19 health guidelines at the time that this research methodology was designed, an optimal plan (in-person participant recruitment and surveying) and alternative backup plan (remote participant recruitment and surveying) were included in the ethics application. The REB's approval of my application was granted on September 17th, 2021. With the express permission of the McGill Arts Faculty, the Head of the Department of Geography, and Montreal Public Health, the optimal plan was carried out from September to November 2021. In-person recruitment and surveying followed strict social distancing and mask guidelines. All identifiable information will be stored on a password protected computer for 7 years.

All surveys, semi-structured interviews, and archival documents have been qualitatively coded to analyze the STM's resilience planning and operations during the COVID-19 pandemic. I utilized inductive coding to identify broad themes which define the subsections of the analysis of Chapters 4 and 5. Surveys are primarily used to investigate the perceived safety of riders and the effect of COVID-19 on use of the Metro among other modes.

3.1 Survey and interviews

3.1.1 General population survey

My final sample is sixty adults of the Montreal population, twenty people being surveyed in each of three selected locations in Montreal: outside the Berri-UQAM Metro station, in Parc Père Marquette in Rosemont, and in Parc St-Joseph in Montreal-Nord. These locations were chosen to seek out participants directly beside a Metro station (Berri-UQAM), within walking distance

(fifteen minutes) of a Metro station (Parc Père Marquette), and beyond walking distance from a Metro station (Parc St-Joseph). This scheme was chosen in order to best obtain a geographically-diverse sample of Montrealers based on their proximity to the Metro network. To achieve systematic sampling I approached every fifth person that passed by (Curtis et al., 2000, 1002). Participants were asked nine questions covering the impact of COVID-19 and the STM's resilience initiatives on personal mobility choices, and perceived safety on the Metro (see Appendix B). Per the REB approval, all participants involved in this project were required to be at least eighteen years of age.

Consent from survey participants was obtained orally to minimize the time necessary to complete the survey, given that the consent procedure was straightforward. All survey participants remained anonymous, as no identifying characteristics were collected. Prospective participants were informed that any "direct benefits [were] unlikely," to aid them in making a fully-informed decision whether or not to participate (Stamm, 2018, 139). Research participants were informed that they risked emotional harm given the triggering nature of COVID-19 subject matter. To address this, participants were offered a list of 24/7 Canadian mental health counseling and crisis intervention resources (see Appendix G).

3.1.2 Semi-structured interviews

Following the conclusion of each survey, each participant was invited to take part in an extended, remote, semi-structured interview at a later date. Interview participants were entered into a drawing for $50, to incentivize their involvement. Participants were not made aware of this incentive opportunity until the survey had formally concluded. Six of the sixty survey participants (10%) elected to participate in semi-structured interviews. The interview material expanded upon that covered in the survey, prompting participants for more in-depth responses on how their mobility choices were formed before the pandemic, during the pandemic, and prospectively for the future (see Appendix C). Conducted on Microsoft Teams software, interviews lasted between six and 20 minutes long, spanning eight guiding questions and conversational follow-ups. Consent was obtained through the digital signature of an informed consent sheet. Interview participants were informed that their identities would remain

confidential to avoid any harms that could result from the publication of their name (DeWalt and DeWalt, 2011, 49). Audio of each interview was recorded, entered into Otter transcription software, and then manually corrected. The audio recordings were erased upon completion of the transcription process. A table, assigning pseudonyms and identifying the occupation of each interviewee (if they shared their occupation unprompted), can be found in Chapter 5 (Figure 5).

Additionally, I conducted an email interview with a Corporate Advisor of the STM. The 11 questions prompted covered the STM's approach to COVID-19 resilience planning, ridership levels during the pandemic, and the organization's place in Montreal's mobility networks (see Appendix D). I was directed to the participating representative through an inquiry to the organization's office for interview and data requests. Consent was obtained through digital signature of an informed consent sheet. Per the REB agreement, the identity of the STM Corporate Advisor will remain anonymous. The interview was intended to be a semi-structured, live, remote interview, however the company preferred to send written responses. The respondent's answers were written in French, and translated to English by a volunteer for this project. The English translations will appear in the text of Chapter 4.

3.2 Document analysis

3.2.1 STM documents

Archival research was completed by assessing and coding documents published by the STM during the COVID-19 pandemic. This includes COVID-19 specific press releases, reports and briefings, and budgetary documents. A review of these documents has facilitated an analysis of the STM's public self-reflection on their COVID-19 resilience efforts.

3.2.2 "My Voice My STM" surveys

I have coded the questions of 10 "My Voice My STM" surveys, distributed between February 23, 2020, and March 4, 2022. These surveys are routinely distributed by the STM via email to over 20,000 respondents who have voluntarily signed up for the service. The STM offers monthly and quarterly drawings for cash rewards for participants. The data of survey responses are kept private by the STM, and are therefore inaccessible for this project. Therefore, I recorded only the

questions prompted by the STM in these surveys to gain insight on areas of interest which the STM is concerned with collecting feedback on. Survey questions which tackle how respondents perceive their safety on the Metro at different stages in the pandemic, and gauge respondents' feelings towards current and future measures for improving confidence in safety. I have used the STM's survey questions in tandem with my own surveys and interviews to build a profile of the STM's transportation resilience efforts, their approach to collecting rider feedback, and riders' attitudes.

3.3 Ethical and sampling considerations

The surveys outlined in my methodology could not be completed until public health and McGill administrative guidelines permitted in-person, local fieldwork. This delayed my data collection until November 2021. While my alternative plan based on remote surveying was approved by the REB, I insisted on waiting for regulations to allow for in-person activity so that my prefered sampling scheme could be carried out.

My limited knowledge of French posed a barrier for interviewing members of the general population, and in communications with the STM. This potentially excluded monolingual French speakers from participating in this project. It may have additionally limited the ability of some bilingual respondents to express themselves to the best of their ability by having to respond in English. Furthermore, a significant amount of the STM's budgetary and administrative literature is only published in French. This has required translating materials when deemed necessary. Ventures into elite interviewing, in regards to communications with the STM, presented a major challenge to gain access and acquire trust. Securing an interview opportunity took a number of attempts to make contact, back and forth communication with the STM, and an adjustment of interview procedure to meet their terms.

CHAPTER 4: EVALUATING THE STM'S RESILIENCE PLANNING

The STM's approach to promoting static resilience, as defined in Rose's (2007) model, is examined in the first section of this chapter. The STM has found that riders' most significant pandemic concerns include: cleanliness of Metro stations and trains, temporary withdrawal of cash at stations, Metro service adjustments during the month of April (when service was reduced by 20% on the orange and green lines), reimbursement requests following confinement, and the attitude of customers in the Metro (non-compliance with health measures) (STM, 2021e: online). With the budget for full service secured through the summer 2022 (establishing static resilience for the time being), the STM shifted much of their focus during the pandemic to meeting consumer demands for new and adapted measures to respond to COVID-19. The STM worked to strategically address the new safety concerns of riders to promote dynamic resilience, and the return of confident ridership. Evaluating material on the STM's pandemic decision making process – centered around service offerings, COVID-19 safety measures, and community confidence building campaigns – yields a comprehensive understanding of the agency's path to restore ridership.

4.1 Service offering

4.1.1 Customer and Employee Safety

At the onset of the pandemic, the STM's approach to COVID-19 was directed to establishing static resistance by maintaining service offerings. During the immediate response period from March 30th to May 8th, 2020, Metro service on the orange and green lines was reduced by 20%, while blue and yellow line service remained unchanged (STM, 2021e: online). After five weeks of deliberation with public health, Metro service was fully restored, and has remained at full service ever since. The STM called this choice a "crucial decision for our future and the future of public transit in Montreal", marking the significance in decision making that took place in a time of immense uncertainty (STM, 2020d: online). Signified by their unofficial slogan "build it and they will come" – words of STM CEO Luc Tremblay – the Montreal transit authority deviated from the behavior of many fellow North American transit services in cities such as New York, Boston, and Washington D.C., which cut transit service temporarily in response to rapidly

declining ridership. Cutting service is a solution to address the massive loss of revenue brought on by declining ridership, but led to longer wait times, feelings of unreliability amongst riders, and a higher likelihood for inadequate physical distancing. Together these factors reduce incentives for riders to continue taking public transit. Without the stability and safety that previously defined transit, riders may be more likely to turn to using private cars. Reaching the desired outcome of this vision, a state of 'normal functioning', was predicated on encouraging Montrealers to return to the same service they knew with additional safety measures in place to promote confident riding.

The STM cited two primary motivations in resuming operation of the Metro network at full service: (1) to support essential workers relying on public transit; and (2) to "ensure a safe environment that allows for some physical distancing" (STM, pers. comm., November 24, 2021; STM, 2020d: online). Maintaining an essential service for essential workers supported their efforts in working full-time through the pandemic. Providing a service with adequate distancing secured a safe transport option for both essential workers who relied on the Metro, and those taking the Metro by choice for errands or leisure. For essential workers, this eased fears of contracting the virus on public transit, which remained a legitimate fear as the properties of virus transmission were unknown in the early stages of the pandemic. Despite a city-wide curfew in place between January 2021 and May 2021, and once again for two weeks in January 2022, the STM continued running the Metro network at full service (STM, 2021c: online). Full-service offerings provided riders with a higher likelihood of finding adequate distancing on Metro trains and in Metro stations (STM, pers. comm., November 24, 2021). Figure 4.1 showcases a month-by-month breakdown of Metro ridership in 2020 and 2021 as compared to ridership each month in 2019 respectively (STM, pers. comm., November 24, 2021).

	VS PRÉ-COVID[0]		
Mois	Déplacements STM[1]	Entrants métro[2]	Déplacements bus liés[3]
avr 2020	-86%	-91%	-80%
mai 2020	-81%	-89%	-74%
juin 2020	-68%	-80%	-57%
juil 2020	-60%	-72%	-47%
août 2020	-60%	-66%	-53%
sept 2020	-59%	-64%	-52%
oct 2020	-66%	-70%	-58%
nov 2020	-66%	-70%	-56%
déc 2020	-64%	-67%	-56%
janv 2021	-74%	-77%	-67%
févr 2021	-69%	-73%	-61%
mars 2021	-64%	-67%	-57%
avr 2021	-65%	-68%	-59%
mai 2021	-64%	-66%	-58%
juin 2021	-57%	-60%	-49%
juil 2021	-56%	-59%	-48%
août 2021	-52%	-55%	-46%
sept 2021	-44%	-46%	-39%

0. Traffic is compared to the same month in the pre-covid period between March 2019 and February 2020.
1. Linked trips on the regular network, i.e., without considering the number of transfers made to complete the trip. Cannot be used to calculate official monthly or annual ridership, as adjustments for off-system trips are not included.
2. Subway passengers only include those who pass through the turnstiles at the entrance to the stations.
3. Linked, i.e., without considering the number of transfers made to complete the trip.

Figure 4.1: STM early pandemic ridership trends (as compared to 2019)

(Source: STM, pers. comm., November 24, 2021)

The only exception to adequate distancing observed during this time was seen on the orange line, where 4.1% of trips in April 2020 were deemed overloaded according to the STM, meaning that riders on those trains were unable to maintain adequate physical distance (STM, pers. comm., November 24, 2021).

Maintaining a fully functioning service at drastically low ridership levels comes at a significant environmental cost, according to the STM: "maintaining [bus] service offerings at a similar level to 2019 with the drastic drop in ridership due to the COVID-19 pandemic has increased GHGs by 97% for each km traveled by our customers" (STM, 2021e: online). With this in mind, the STM's decision to maintain bus and metro service indicates a high level of commitment to recovering ridership, both environmentally and financially. The rise in short-term emissions will be offset by decades of Metro service to come, if Metro ridership continues to rise, and the use of personal vehicles falls.

4.1.2 Challenges

In the 2021 budget, the STM's desired service offering was guaranteed through the calendar year (and later guaranteed through summer 2022), however an impending financial crisis caused by a "loss of revenue [from ridership decline] combined with the costs related to the major health measures" is brewing (STM, 2021e: online). The STM aims to avoid service cuts, but operates at the mercy of the Autorite Regionale de Transport Metropolitain (ARTM), "responsible for funding the Montreal area OPTCs (Organismes Publics de Transport en Commun or public organizations of public transit)" as of June 1st, 2017 (STM, pers. comm., November 24, 2021). As of June 1st, 2017, the ARTM is "responsible for funding the Montreal area OPTCs (Organismes Publics de Transport en Commun or public organizations of public transit)" (STM, pers. comm., November 24, 2021). Despite optimization efforts that saved $60 million against the projected budget in 2020, the STM representative interviewed reported "the ARTM limited our compensation to actual expenses (thus, reducing our compensation by $60 million)" (STM, pers. comm., November 24, 2021). As a result of these factors the STM has been challenged to identify "new sources of indexed, dedicated and recurring financing"; what they call their biggest challenge for the coming years (STM, 2021b: online). The STM has begun working with officials from the Chambre de commerce du Montréal Métropolitain (Chamber of Commerce of Metropolitan Montreal) to shape their economic recovery plan (STM, 2021e: online). As long as adequate funding remains uncertain, the future of service on the Metro network is not secure. It

is clear the integration of public health objectives and transportation remains at the center of the STM's re-assessed agenda for the next few years.

4.2 COVID-19 safety measures

4.2.1 Protective Measures (Masks, Distancing, etc.)

COVID-19 protection has been promoted as a shared responsibility among the Metro network and its riders, which requires riders to be actively aware of their part in promoting system-wide safety. Riders have been directed to follow markings on the ground indicating the direction of traffic flow to avoid bi-directional traffic (STM, 2020c: online). Additionally, distancing stickers appear on the ground in terminals and platforms to aid in proper distancing in areas where customers are likely to line up (STM, 2020c: online). During this time, music performances, fundraisers, and the distribution of printed material were all prohibited in the Metro network to promote distancing efforts (STM, 2021e: online). On November 29th, 2021, music performances were gradually reintroduced with strict health protocols, utilizing an online booking system for a select number of reservable spaces (see section 4.2.2).

As of July 13th, 2020, the wearing of face masks in the Metro network was made mandatory by Quebec public health guidelines. Thorough measures introduced in the network include frequent cleaning of handrails, fare vending machines, elevators, grab poles, and other surfaces (STM, 2020d: online). The execution of this measure required reassigning administrative and professional STM employees to carry out the intensive program (STM, 2021e: online). 395 hand sanitizer dispensers have been installed throughout the network (STM, 2021e: online). The STM has also invested in electrostatic disinfecting sprayers to more efficiently carry out cleaning operations. Together, the intent of these measures signifies a considerable effort to quell the fear of riders regarding highly touched surfaces, and to "improve the customer experience on public transportation" (STM, 2020b).

4.2.2 Innovative measures

In their 2020 Activity Report, the STM announced the launch of a new digital feature allowing riders to check the occupancy of AZUR (MPM-10) trains on the orange line (STM, 2021e:

online). Displayed on their website, mobile app, and in Metro stations on Metrovision screens, the development allows riders to see four levels of occupancy with near-real-time estimates for each train car: (1) nearly empty; (2) some seats available; (3) standing room only; and (4) nearly full. The most innovative measure put in place by the STM in response to shifted activities during the COVID outbreak, a remote occupancy tool allows riders to adjust their travel choices based on their preferred comfort level. AZUR trains already offer 8% more space and improved ventilation over the older MR-73 model, which still run on the green, blue, and yellow lines (STM, 2021e: online). Because the orange line is the only line which exclusively uses the newer AZUR model, it is the only line that this technology has been made available for. Without full implementation across the Metro network, this feature remains limited in its potential to promote system-wide comfortability.

The STM further prioritized the rollout of contactless debit and credit card payment terminals in all stations, beginning in August 2020 (STM, 2020c: online). Plans to introduce this technology predated COVID-19, but were accelerated as access to contactless methods of payment were brought to a higher level of attention during the outbreak. In adjusting long term plans and investments, this development marks an area which the STM saw as necessary, not to introduce new measures, but rather to prioritize the timeline of future plans given the new context of the pandemic.

In November 2021, the STM announced a new digital reservation platform to allow musicians to book designated spaces in Metro stations to perform. This lifted the previous ban on performances enacted in April 2021, although adding a significant amount of specific measures developed with public health authorities as compared to the unregulated pre-pandemic context. The STM found that a majority of customers surveyed indicated that they were in favor of the return of musicians to Metro stations as it marked “an encouraging sign of a return to a certain normality,” which prompted the agency’s changing attitude towards performances (STM, 2021g: online). While the return is promising for riders’ desire to return to normalcy, the introduction of a system exclusive to online bookings effectively bars any individuals without internet access from participating.

4.3 Coordination and collaboration

4.3.1 Health guidelines

The STM has worked alongside numerous organizations, both public and private, to coordinate a response plan to COVID-19 in line with health and safety guidelines. Under a directive from Public Health, the STM prioritized rider and employee safety as a key prong in their response efforts. Over 1.5 million masks have been distributed by the STM in the Metro network and by mail with promotional material (STM, 2020c: online). This work prompted "constant contact with the City of Montreal and the Direction régionale de santé publique [DRSP]" (STM, pers. comm., November 24, 2021). Sanitary measures approved by Public Health were designed to "establish hygiene rules that [took] into consideration the relation specific to public transportation (STM, 2021e: online). The STM additionally adopted the recommendations of the Commission des normes, de l'équité, de la santé et de la sécurité du travail (CNESST - commission on workplace standards, fairness, health and safety) to promote updated public occupational health and safety system guidelines.

To ensure the proper implementation of measures created alongside Public Health, the STM set up an internal emergency measures unit, with an appointed liaison officer "with the mandate to verify the compliance of decisions" (STM, 2021e: online). With Atun's (2014, 72) assertion that "the largest damage to a resilience plan likely occurs as a result of connections that had never been established between public transit and public health" in mind, the creation of this unit demonstrates the STM's attention to protecting the newly formed connection with Public Health. Closing the gap between health and transportation decision making offers a progressive path to safer traveling during the pandemic and beyond. Once these connections were established, the STM was able to move forward distributing masks and kickstarting communication campaigns to encourage a return to confident riding. The STM loaned the city "5 buses, 7 days a week for 6 weeks… used as mobile clinics to conduct [COVID-19] screening tests in different areas of the city" (STM, pers. comm., November 24, 2021).

4.3.2 Transit information sharing

Furthermore, the STM promoted its commitment to safety by adhering to the American Public Transportation Association's (APTA) program for public-transit-specific safety measures; which has been accepted by 200 participating cities such as New York, Philadelphia, Chicago, and Ottawa (STM, 2021e: online). Working with transit coalitions promotes a global network of transit-specific information, key for innovative and appropriate measures as the understanding of COVID-19 transmission continues to progress over time. The STM:

> is a member of several transportation associations (including the Association du Transport Urbain du Québec, Association Québécoise des Transports, Canadian Urban Transit Association, and the Union Internationale des Transports Publics) as well as the Imperial College London benchmark communities (CoMET and the International Bus Benchmarking Group). There is a great deal of information exchange between transportation companies and operators in Canada and around the world (STM, pers. comm., November 24, 2021).

4.4 Community outreach campaigns

4.4.1 Confidence building

Moving towards Atun's (2014, 67) third phase of resilience planning – recovering from a shock or stressor – it is necessary to evaluate the STM's outreach initiatives for retaining and recruiting riders. A number of communication campaigns in social media, signage, and physical mail have drawn attention to certain qualities of the Metro network and its riders in the context of the pandemic, to encourage support of the STM's resilience planning and its outcome.

Let's Take Care of Each Other, a campaign launched in July 2020, was created to broadly educate customers who had not taken the Metro or bus since the introduction of mask mandates. Over time the target of the campaign shifted, evolving with riders' comfortability needs and pressure to encourage a city-wide return to public transportation as the City of Montreal began introducing deconfinement measures. By April 2021 the STM began promoting the campaign with satirical posters showcasing 18 incorrect ways to wear a mask, with delineations for improper mask wearing based on horoscope signs, and a final image depicting the proper way to wear a mask; see Figure 4.2 (STM, 2021e). The posters were placed throughout the Metro network to "raise awareness of the small proportion of customers who, through ignorance or

negligence, do not wear face coverings the right way" (STM, 2021e: online). Improper mask procedure was the most commonly cited source of discomfort for Metro riders during the pandemic among those interviewed for this project. The STM addressed these concerns in part by adapting the focus of the campaign as defiance of the public transit mask mandate became a focal point of riders' fears.

Additionally the STM launched the *votre routine a change* [*change your routine*] campaign in April 2021, designed to "highlight the new reality of public transit in Montreal, and to give customers confidence" (STM, 2021e: online). Through radio, tv, social media, billboard, and physical mail advertisements, the STM educated Montrealers about the cleaning initiatives and other actions implemented to encourage confidence in the network. The campaign launched with the anticipation of increasing ridership rates in the fall of 2021, coinciding with the return of some schools to in-person or hybrid teaching activities. Mail was sent to nearly 500,000 households, with some packages including a free mask (STM, 2021e: online). In tandem, #*cavabienaller*, was promoted as a hashtag for riders to use on social media to spread messages of support for others during the difficult conditions of the pandemic (STM, 2021e: online).

Figure 4.2: *Let's Take Care of Each Other* campaign display in Metro network
(Source: STM, 2021e)

The *Defi STM* stands out as the agency's most unique public outreach program for community resilience. In collaboration with Canada Running Series the STM launched a "reinvented footrace" from June 1st to June 30th, 2021, inviting participants to "travel the length of the Montreal Metro network (66 km) by walking or running through the city, while also using the bus and Metro networks to get around" (STM, 2021e: online). The activity combined exercise and use of public transport in a unique combination to promote exploration of the neighborhoods along the Metro network after nearly fifteen months of the pandemic (STM, 2021d: online). This program is suggestive of the STM's first attempt to bring innovative and inclusive programs to the community to help riders "gradually get comfortable with their transit network again", with other similar ideas popping up in the *My Voice My STM* surveys; see Figure 4.3 (STM, 2021e: online). One survey prompt listed a number of potential activities the STM has considered to boost interest in the Metro network. Respondents were given four multiple choice responses for each activity: not at all interested, not very interested, somewhat interested, and very interested.

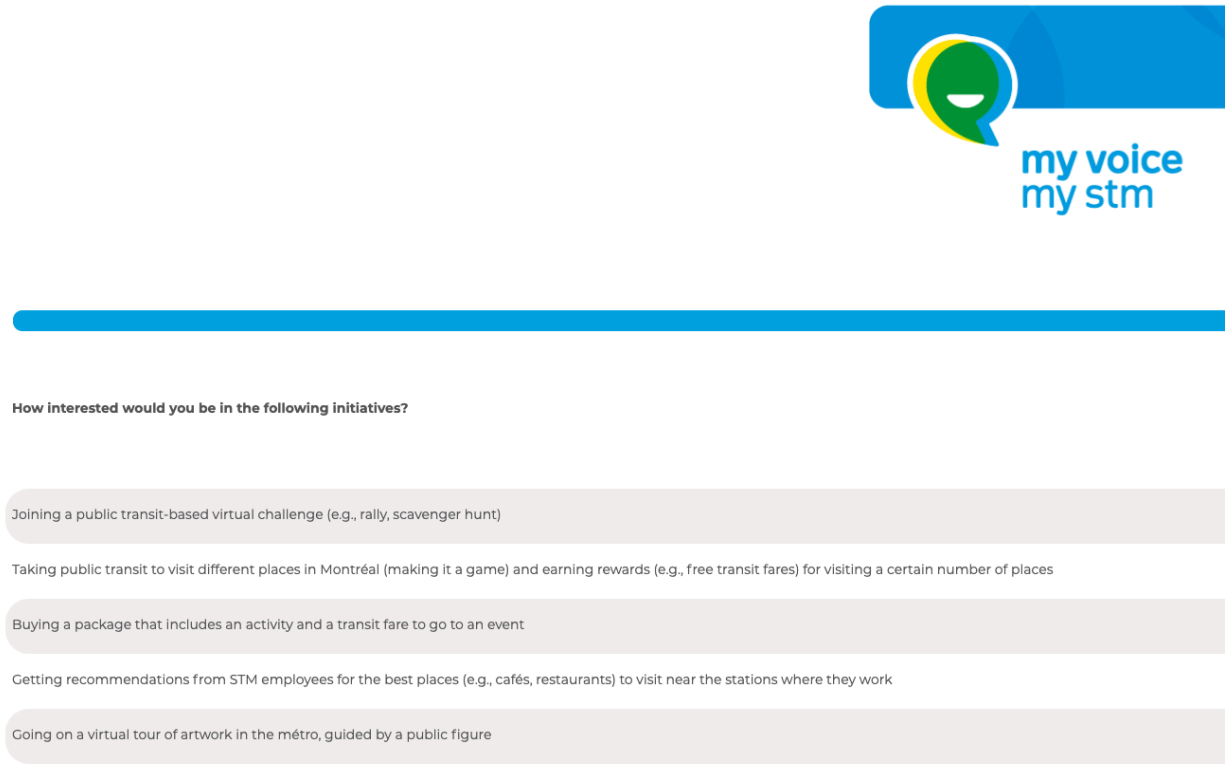

Figure 4.3: STM's proposed resilience initiatives
(Source: *MyVoiceMySTM* Survey 2/25/21)

Offering both accessible mode choice and a flexible period to complete the race meant that the activity encouraged Montrealers of all running experience and ability levels to participate. In addition, the *Defi STM* promoted integrated mobility by combining active mobility with public transportation, as the agency has suggested that the two offer "an excellent alternative to the solo car ride" (STM, pers. comm., November 24, 2021). At a minimum cost of $30, participants received a mug, running belt, and set of magnets. $5 of every registration was donated to one of four charities: Centraide du Grand Montreal, the Canadian Red Cross, Partenaire Santé Québec, and Rechaud-Bus (STM, 2021e: online). The activity also offered participants the opportunity to raise money through their run for a charity of their choice. In promoting physical health, mental health, charitable donations, and an integrated mobility agenda, the *Defi STM* proved to be a creative approach to excite Montrealers about public transportation again.

4.4.2 Attention for employees

Launched in April 2021, *Un coeur qui voyage* [*A traveling heart*], spotlighted STM service employees who continued to work through the pandemic. Created to remind the public of the duty that STM workers performed through the uncertainty of the pandemic, the month-long campaign can be found on signs in Metro stations, on the sides of buses, and at bus shelters. This marks the STM's only city-wide campaign directed entirely towards their employees. The STM representative stated during my interview that the gesture "invited clientele and all Montrealers to participate in a positive movement and thus create a larger chain of solidarity" (STM, pers. comm., November 24, 2021). The interview conducted with that STM employee did not cover employee sentiments towards the STM's pandemic response planning. Without this perspective, it is unclear how the campaign has been received by STM employees. The STM reported that employees were "very worried" about contracting the virus during work during the first seven weeks of city-wide shutdown in March and April 2020, which prompted the STM to "show resilience and goodwill in putting the necessary measures in place" (STM, pers. comm., November 24, 2021).

CHAPTER 5: PANDEMIC MODE CHOICE AND MOBILITY

The outbreak of COVID-19 was marked by a lack of comprehensive understanding of the virus' properties and transmission, causing widespread fear and panic. The vast majority of operations in the city were shut down or transitioned to remote formats, forcing every-day commuters to stay home. Taylor, a public health expert, suggested that for many people "the perception of how they engage in public space has changed" (Taylor, pers. comm., October 15, 2021).

The six people who completed surveys and offered to participate in short semi-structured interviews have been assigned pseudonyms. If a participant made their occupation clear, unprompted, it has been included in their profile; see Table 5.1.

Interview ID	Pseudonym	Occupation
A	Sam	Retired teacher
B	Morgan	Retired Montreal Department of Transportation employee
C	Taylor	Public health professional
D	Ray	Essential healthcare worker
E	Danny	Student
F	Alex	Working professional (exact occupation unknown)

Table 5.1: Interviewee identification table

5.1 Reasons people stopped taking public transit

5.1.1 Remote work and lockdown

The closure of businesses and the transition of workplaces and schools to remote formats had a measurable impact on the ridership of the Metro. The shutdown led people, en masse, to adopt more localized lifestyles, forcing mobility patterns to change significantly. Commuters are a key cohort in discussions surrounding pandemic response planning. During the first lockdown, essential workers made up the vast majority of transit users. As the future of remote work

remains difficult to predict, it is clear that some commuters prefer to continue working remotely, which may result in lower public transport ridership.

Interviewee Morgan, a former employee of the Montreal Department of Transportation, offered two predictions of the impact of remote work on public transit ridership: "less demand for services and an increase in commuters by personal vehicle, as a result of more available parking spaces in the downtown core" (Morgan, pers. comm., October 7, 2021). Beyond essential workers, "understanding that the behavior of people who are much more vulnerable and have to be much more economically active during the pandemic" is paramount to studies of riders and their unique risk perception (Taylor, pers. comm., October 15, 2021).

5.1.2 Fear in public spaces

Anxieties in public spaces during the pandemic were amplified in the Metro network, where riders may be standing or sitting indoors in high traffic, enclosed areas. New fears associated with the Metro were especially high early in the pandemic due to frequent use of handrails, poles, fare terminals, and other surfaces on trains and in stations. The presence of the psychological dread risk effect arose as qualities of the virus' transmission were not understood early on in the pandemic (Litman, 2020, 2). Growing sentiments perpetuating the unjustified idea that public transit posed a massive risk for COVID-19 transmission sparked a petition which gained nearly 10,000 digital signatures to shut down the Metro network (Change, 2020: online). Ray, an essential healthcare worker, described their experience on the Metro in April and May 2020 as "unpleasant, and definitely uncomfortable" (Ray, pers. comm., October 19, 2021). This comes despite a 91% drop in ridership in April, and a 89% drop in May (as compared to ridership levels in 2019; see chart in section 4.1.1). The uncertainty of how COVID-19 is transmitted made it difficult for riders to make fully informed decisions, leading to a migration of riders to other modes that were perceived to be safer. Among participants surveyed, only 33% of pre-pandemic Metro commuters continued commuting via Metro during the pandemic, while 33% switched to taking private vehicles, and 33% switched to 'other' (most often indicating remote work or no commute at all).

As the pandemic progressed, more information on the spread of COVID-19 was understood. The STM has now confidently reported that public health authorities and experts have observed no outbreaks linked to the Metro network (STM, pers. comm., November 24, 2021). Almost all STM customers (94%) modified their travel habits following the outbreak of COVID-19, yet perceptions of the STM and the level of confidence in its service have stabilized, according to an April 2, 2020 press release from the company (STM, 2020a: online). While many people reported increased confidence in their own perceived safety on the Metro over time, Taylor was driven away: "as time went on, more and more people started taking the bus and the Metro, and that's when I was like, no, there's too many people, I have to drive" (Ray, pers. comm., October 19, 2021). Despite measures to proactively address the spread of COVID-19, all while the STM reports no outbreaks, a healthcare worker was specifically driven away from public transit by fear of increasingly crowded public spaces (STM, 2021h: online). That individual stopped taking the Metro altogether as a result of being uncomfortable, opting to learn to drive (as a previous non-driver). They stated "the pandemic sort of pushed me to become a driver… which at first was stressful and now has become a source of freedom" (Ray, pers. comm., October 19, 2021). This sentiment opposes the STM, Public Health, and City of Montreal's collective efforts to re-instill confidence in public transit, incurring massive financial deficits in the process.

On the other hand, Alex, a working professional, reported preferring "more people than less people" on the Metro for non-covid-related safety (Alex, pers. comm., October 27, 2021). People who commuted via the Metro prior to the pandemic reported on average feeling 6.5 out of 10 in terms of personal safety, while people who commuted via the Metro during the pandemic reported feeling a 4 out of 10 on average. This indicates not only that comfortability around others in the pandemic was a major detriment to Metro ridership, but additionally that riders have significant non-COVID safety concerns about the Metro network which also factor into their decision making process.

The most commonly cited concern with the STM's pandemic safety measures center on the agency's enforcement of the mask mandate. Sam asserted that: "nobody tells anybody to wear their masks properly, even the employees", causing the interviewee to have to move to

another area of the train or platform (Sam, pers. comm., October 6, 2021). On those who do not wear masks properly, Sam stated: “at first I would tell them to put the mask on properly, but people get mad” (Sam, pers. comm., October 6, 2021). In 2022 the STM will increase the number of STM inspectors and special constables in the Metro network, however interviewed riders have not been impressed by their presence thus far (STM, 2021h: online). By offering full service during periods of extremely low ridership, the STM has facilitated a situation where riders have a higher likelihood of being in a Metro station or train with enough space to distance themselves from another rider who is noncompliant with COVID-19 measures. Sam reported appreciating the spaciousness of Metro cars when in the presence of riders who were not wearing their masks properly, or who were displaying symptoms of COVID-19 (Sam, pers. comm., October 6, 2021). As compared to a bus, Metro train cars (specifically AZUR trains) offer more space for passengers to spread out to a distance that suits their comfortability. Still, the STM is required to enforce these measures as part of their obligation to protect riders and employees. Upset with the STM’s enforcement of health measures, Alex pondered: “who is on the lookout?” (Danny, pers. comm., October 20, 2021).

5.2 Return to the Metro

5.2.1 Measuring the STM’s response

With a better understanding of the spread of COVID-19, confidence in personal safety on the Metro and a return to some in-person activities brought about a consistent rise in ridership over time. During the summer of 2020 (June-August), ridership on the Metro was on average 72.6% lower than in summer 2019. In summer 2021, ridership was only on average 58% lower than averages of summer 2019 (STM, pers. comm., November 24, 2021). This climb of 14.6% marks a significant improvement in summer ridership, however still far from the most recent pre-COVID numbers. In September 2021, ridership continued to rise to be 46% lower than the average ridership in September 2019. This marks the first time that the Metro has regained more than half of the ridership it lost since the beginning of the pandemic, a promising sign of a slow return to a (new) normality.

The majority of the six Montrealers interviewed cited knowledge about COVID-19 transmission as a leading factor in their choice to return to the Metro. Sam explained: “At first, we didn’t know anything about COVID-19. So I was a lot more concerned and anxious about it. But you know… it’s part of our daily life now. So I don’t worry about it as much, as I’m more informed” (Sam, pers. comm., October 6, 2021). Morgan specifically cited the publications made by the STM on the safety of public transportation as positively influencing their decision to return to the Metro (Morgan, pers. comm., October 7, 2021). These trends make it clear that as an enclosed space, with high traffic flows of people moving all over the city, that the Metro appeared to be a high-risk area to inhabit through the early stages of the pandemic where public health warnings urged people to avoid any contact or close proximity to others. After months of isolation and time to deliberate on a return to using the Metro, Taylor stated:

> I took three to four months to make serious adjustments. After that, I felt really good, because I was well informed, there wasn’t any panic on my side. I felt really comfortable, I had a sense of what was going on. (Taylor, pers. comm., October 15, 2021).

Once equipped with valuable information on the safety of the Metro, and aware of the many new measures in place for their protection, many riders have regained trust in their personal safety while on the Metro. Looking at the Metro as a necessity, Taylor stated that: “the Metro for me is my life, if it’s gone my entire lifestyle would change” (Taylor, pers. comm., October 15, 2021).

CHAPTER 6: CONCLUSION

In prioritizing their transit services as essential infrastructure in the city, the STM supported their commitment to promoting integrated mobility alongside the city's investments in public transit, cycling, and pedestrian infrastructure (STM, pers. comm., November 24, 2021). Through their initiatives to protect riders and workers, The STM has demonstrated that Montrealers can depend on their city's public transport options as the climate emergency continues on. Establishing public transportation as essential infrastructure is a key component to promoting use of these services through shocks and stressors such as the pandemic.

Still, despite the efforts of the STM and City of Montreal, there are concerns that the pandemic has promoted personal car usage, based on perceived safety, convenience, and changing in commute patterns. The STM asserts that "they do not yet know their real long-term impacts and the new balance that will emerge in terms of travel needs." (STM, pers. comm., November 24, 2021). A future of remote working and distrust in the safety of public transit together will require increased public awareness efforts on the benefits that public transit uptake holds for the rider, our cities, and our climate. "One thing is certain, in the context of global warming, the public transit system plays and will play an essential role" (STM, pers. comm., November 24, 2021). Montreal's path to a sustainable future lies in continued use of the Metro system. This requires upholding a level of safety that keeps riders satisfied, and able to justify leaving their cars behind.

REFERENCES

Beckett, C., & Clegg, S. (2007). Qualitative Data from a Postal Questionnaire: Questioning the Presumption of the Value of Presence. *International Journal of Social Research Methodology, 10(4)*, 307-317. https://doi.org/10.1080/1364557070140124

Besser, L., & Dannenberg, A. (2005). Walking to Public Transit: Steps to Help Meet Physical Activity Requirements. *American Journal of Preventive Medicine, 29(4)*, 273-280. https://doi.org/10.1016/j.amepre.2005.06.010

CBC News (2021, October 15). *STM warns of big cuts to Montreal public transit next year unless it's bailed out.* https://www.cbc.ca/news/canada/montreal/stm-service-cuts-1.6211998

Change. (2020). *Fermeture des métros pour mettre fin au Covid-19*. https://www.change.org/p/tva-nouvelle-fermeture-des-m%C3%A9tros-pour-mettre-fin-au-covid-19?recruiter=780190756&utm_source=share_petition&utm_medium=facebook&utm_campaign=share_petition&utm_term=share_petition&recruited_by_id=e862b370-9706-11e7-abeb-8fad403541fb&utm_content=starter_fb_share_content_fr-fr:v2

Chen, C-F., & Chao, W-H. (2011). Habitual or Reasoned? Using the Theory of Planned Behavior, Technology Acceptance Model, and Habit to Examine Switching Intentions toward Public Transit. *Transportation Research Part F: Traffic Psychology and Behaviour, 14(2)*, 128-137. https://doi.org/10.1016/j.trf.2010.11.006

Cox, A., Prager, F., & Rose, A. (2010). Transportation Security and the Role of Resilience: Foundation for Operational Metrics. *Transport Policy, 18(2)*, 307-317. https://doi.org/10.1016/j.tranpol.2010.09.004

Curtis, S., Gesler, W., Smith, G., & Washburn, S. (2000). Approaches to Sampling and Case Selection in Qualitative Research: Examples in the Geography of Health. *Social science & medicine (1982), 50 (7-8)*, 1001-1014. https://doi.org/10.1016/s0277-9536(99)00350-0

DeWalt, K., & DeWalkt, B. (2011). *Participant Observation: A Guide for Fieldworkers* (2nd ed.). AltaMira Press. https://rowman.com/ISBN/9780759119284/Participant-Observation-A-Guide-for-Fieldworkers-Second-Edition

Funda, A. (2014). *Improving Societal Resilience to Disasters: a Case Study of London's Transportation System*. Springer. https://doi.org/10.1007/978-3-319-04654-9

Heath, Y., & Gifford, R. (2002). Extending the Theory of Planned Behavior: Predicting the Use of Public Transportation. *Journal of Applied Social Psychology, 32(10)*, 2154–2189. https://doi.org/10.1111/j.1559-1816.2002.tb02068.x

Litman, T. (2003). Integrating Public Health Objectives in Transportation Decision-Making. *American Journal of Health Promotion, 18(1)*, 103-108. https://doi.org/10.4278/0890-1171-18.1.103

Litman, T. (2020). Terrorism, transit and public safety: evaluating the risks. *Victoria Transport Policy Institute*, 1-15. https://www.vtpi.org/transitrisk.pdf

Prager, F., Asay, G., Lee, B., & Winterfeldt, D. (2011). Exploring Reductions in London Underground Passenger Journeys Following the July 2005 Bombings. *Risk Analysis, 31(5)*, 773–786. https://doi.org/10.1111/j.1539-6924.2010.01555.x

Rose, A. (2007). Economic Resilience to Natural and Man-Made Disasters: Multidisciplinary Origins and Contextual Dimensions. *Environmental Hazards, 7(4)*, 383-398. https://doi.org/10.1016/j.envhaz.2007.10.001

Serebrin, J. (2020, December 16). *'Build it and they will come': Canada's public transit looks to rebound from COVID-19.* The Star. https://www.thestar.com/news/canada/2020/12/16/build-it-and-they-will-come-canadas-public-transit-looks-to-rebound-from-covid-19.html

Société de transport de Montréal. (2020a, April 2). An update on the impacts of adjustments to the STM's service [Press release]. Retrieved from https://www.stm.info/en/press/press-releases/2020/an-update-on-the-impacts-of-adjustments-to-the-stm-s-service

Société de transport de Montréal. (2020b, November 26). STM introduces occupancy levels for metro network customers [Press release]. Retrieved from https://www.stm.info/en/press/press-releases/2020/stm-introduces-occupancy-levels-for-metro-network-customers

Société de transport de Montréal. (2020c, July 10). The STM presents its plan to ease up the mandatory wearing of face coverings [Press release]. Retrieved from https://www.stm.info/en/press/press-releases/2020/the-stm-presents-its-plan-to-ease-up-the-mandatory--wearing-of-face-coverings

Société de transport de Montréal. (2020d, November 10). The STM's 2021 budget and 2021-2030 Capital Expenditures Program: Relaunching Montreal public transit [Press

release]. Retrieved from https://www.stm.info/en/press/press-releases/2020/the-stm-s-2021-budget-and-2021-2030-capital-expenditures-program--relaunching-montreal-public-transit

Société de transport de Montréal. (2021a, November 25). Additional help - The STM welcomes the Quebec government's response [Press release]. Retrieved from https://www.stm.info/en/press/news/2021/aide-supplementaire---la-stm-salue-la-reponse-du-gouvernement-du-quebec--french-only-

Société de transport de Montréal. (2021b, December 22). Budget 2022 et PI 2022-2031 de la STM: Poursuivre la relance du transport collectif dans un contexte de crise sanitaire [Press release]. Retrieved from https://www.stm.info/fr/presse/communiques/2021/budget-2022-et-pi-2022-2031-de-la-stm---poursuivre-la-relance-du-transport-collectif--dans-un-contexte-de-crise-sanitaire

Société de transport de Montréal. (2021c, January 8). New lockdown measures – STM update [Press release]. Retrieved from https://www.stm.info/en/press/press-releases/2021/new-lockdown-measures---stm-update

Société de transport de Montréal. (2021d, May 12). STM launches challenge combining public transit, physical activity and exploring the city [Press release]. Retrieved from https://www.stm.info/en/press/press-releases/2021/stm-launches-challenge-combining-public-transit--physical-activity-and--exploring-the-city

Société de transport de Montréal. (2021e, April 8). STM presents its 2020 Annual Report a year filled with challenges [Press release]. Retrieved from https://www.stm.info/en/press/press-releases/2021/stm-presents-its-2020-annual-report-a-year-filled-with-challenges

Société de transport de Montréal. (2021f, April 30). The STM and its partners report positive results for the 2020-2021 winter plan in the métro network [Press release]. Retrieved from https://www.stm.info/en/press/press-releases/2021/the-stm-and-its-partners-report-positive-results-for-the-2020-2021-winter-plan-in-the-metro-network

Société de transport de Montréal. (2021g, November 10). The STM announces the gradual return of musicians to the metro [Press release]. Retrieved from https://www.stm.info/fr/presse/communiques/2021/la-stm-annonce-le-retour-progressif-des-musiciens-dans-le-metro

Société de transport de Montréal. (2021h, December 23). The STM updates its measures to the current public health situation [Press release]. Retrieved from https://www.stm.info/en/press/news/2021/the-stm-updates-its-measures-to-the-current-public-health-situation

Société de transport de Montréal. (2021i). *Une année de réalisations et de défis exceptionnels: Rapport d'activité 2020*. https://www.stm.info/sites/default/files/pdf/fr/ra2020.pdf

Société de transport de Montréal. (2021j). *What's changed since the pandemic.* Retrieved February 10, 2021, from https://stm.info/en/info/advice/handy-guide-reconnection/whats-changed-pandemic

Stamm, C. (2018). Gatekeeping Success in the Namibian CBNRM Program: Ethical and Emotional Challenges in the Field. *The Politics of Conducting Research in Africa*, 133-151. https://doi.org/10.1007/978-3-319-95531-5_8

Statistics Canada (2016). *Census Profile, 2016 Census: Montréal, Ville [Census subdivision], Quebec and Montréal, Territoire équivalent [Census division], Quebec.* https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=2466023&Geo2=CD&Code2=2466&SearchText=montreal&SearchType=Begins&SearchPR=01&B1=All&TABID=1&type=0

Urlanis, A., Shohet, I., Levy, R., Ornai, D., & Vilnay, O. (2014). Damage in Critical Infrastructures Due to Natural and Man-Made Extreme Events – A Critical Review. *Procedia Engineering, 85(1)*, 529-535. https://doi.org/10.1016/j.proeng.2014.10.580

Wang, H., & Noland, R. (2021). Changes in the pattern of bikeshare usage due to the COVID-19 pandemic. *Findings*, 1-8. https://doi.org/10.32866/001c.18728

Weilant, S., Strong, A., & Miller, B. (2019). *Incorporating Resilience into Transportation Planning and Assessment*. https://www.researchgate.net/publication/336617146_Incorporating_Resilience_into_Transportation_Planning_and_Assessment

Zhou, Y., Wang, J., & Yang, H. (2019). Resilience of Transportation Systems: Concepts and Comprehensive Review. IEEE Transactions on Intelligent Transportation Systems, 20(12), 4262–4276. https://doi.org/10.1109/tits.2018.2883766

APPENDIX A: REB Approval Certificate

McGill

Research Ethics Board Office
James Administration Bldg.
845 Sherbrooke Street West. Rm 325
Montreal, QC H3A 0G4

Website: www.mcgill.ca/research/research/compliance/human/

Research Ethics Board 1
Certificate of Ethical Acceptability of Research Involving Humans

REB File #: 21-08-044

Project Title: Investigating the Effects of COVID-19 on the Operations of and Use of the Montreal Metro

Principal Investigator: Prof. Kevin Manaugh

Dept: Geography

Co-researchers: Zachary Beresin, UG McGill University

Funding:

Approval Period: **September 17, 2021 to September 16, 2022**

The REB-1 reviewed and approved this project by delegated review in accordance with the requirements of the McGill University Policy on the Ethical Conduct of Research Involving Human Participants and the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans.

Deanna Collin
Research Ethics Officer

---

* Approval is granted only for the research and purposes described.
* Modifications to the approved research must be reviewed and approved by the REB before they can be implemented.
* A Request for Renewal form must be submitted before the above expiry date. Research cannot be conducted without a current ethics approval. Submit 2-3 weeks ahead of the expiry date.
* When a project has been completed or terminated, a Study Closure form must be submitted.
* Unanticipated issues that may increase the risk level to participants or that may have other ethical implications must be promptly reported to the REB. Serious adverse events experienced by a participant in conjunction with the research must be reported to the REB without delay.
* The REB must be promptly notified of any new information that may affect the welfare or consent of participants.
* The REB must be notified of any suspension or cancellation imposed by a funding agency or regulatory body that is related to this study.
* The REB must be notified of any findings that may have ethical implications or may affect the decision of the REB.

APPENDIX B: In-Person Questionnaire Guide

Q: Do you confirm that you are 18 years of age or older?

1: Yes

2: No

Q1: Prior to the pandemic, how often did you take the Metro?

1: Never

2: Nearly never

3: Less than once a week

4: A few times a week

5: Most days

Q2: Have you used the Metro since the beginning of the COVID-19 pandemic?

1: Yes

2: No

Q3: Prior to the pandemic, what method of transportation did you use most often?

	For work or school	For errands/groceries/etc.	For leisure
Walking			
Bicycle			
Bus			
Metro			
Private vehicle			
Other (specify)			

Other: _____

Q4: During the pandemic, what method of transportation did you use most often?

	For work or school	For errands/groceries/etc.	For leisure
Walking			
Bicycle			
Bus			
Metro			
Private vehicle			
Other (specify)			

Other: _____

Q5: Assuming everything returns to pre-COVID-19 conditions, for your commute would you prefer to go by:

	For work or school	For errands/groceries/etc.	For leisure
Walking			
Bicycle			
Bus			
Metro			
Private vehicle			
Other (specify)			

Other: _____

Q6: What was your level of concern regarding use of the Metro during the pandemic?

1: Not at all concerned

2: Not very concerned

3: Somewhat concerned

4: Very concerned

Q7: What is your current feeling of security with regard to the Metro system?

1: I don't feel safe at all

2:

3:

4:

5: Indifferent

6:

7:

8:

9:

10: I feel very safe

Q8: Overall how concerned were you about COVID-19?

1: Not at all concerned

2: Not very concerned

3: Somewhat concerned

4: Very concerned

Q9: Has your willingness to use the Metro changed from the start of the pandemic until now

1: My willingness to take the Metro has worsened

2:

3:

4:

5: My willingness to take the Metro has not changed

6:

7:

8:

9:

10: My willingness to take the Metro has improved

Q: Thank you for participating. Would you like to participate in a follow up remote interview, lasting no longer than 30 minutes, expanding upon the topics covered in this survey today? If you participate in that interview, you would be entered into a drawing for $50.

APPENDIX C: Remote Semi-Structured Interview Guide for General Population

Q1: Tell me about your daily mobility patterns prior to the pandemic:

Q2: Prior to the COVID-19 pandemic, what factors would affect why you chose to take the Metro over other methods of transportation?

Q3: Has the COVID-19 pandemic affected your comfortability in crowded public spaces?

Q4: Today, how do you make your transportation choices given the current status of the COVID-19 pandemic?

Q5: How did your transportation patterns change over the course of the pandemic?

Q6: Prior to the pandemic, was the risk of catching an illness a factor that influenced whether or not you took the Metro?

Q7: Prior to the pandemic, would safety concerns affect your choice whether or not to use the Metro?

Q8: Do you think that COVID-19 will have long-term impacts on your transportation choices?

APPENDIX D: Remote Semi-Structured Interview Guide for STM Official

Q1: Tell me about how operations changed when the COVID-19 pandemic first began to shut down jobs, schools, etc. in February 2020?

Q2: How has ridership trended over the course of the COVID-19 pandemic?

Q3: What social distancing or sanitary measures have been put in place to promote safe riding?

Q4: How has your transit system aimed to promote resilience in the face of the pandemic?

Q5: Have you looked at how other transit systems handled the pandemic to structure your response?

Q6: Did you face any roadblocks in coordinating a response to ridership trends?

Q7: How do you measure passenger satisfaction?

Q8: What role does the transit system have in the city's response to the pandemic, in trying to move forward through unforeseen circumstances?

APPENDIX E: In-Person Questionnaire Oral Consent Script

Hello, my name is Zachary Beresin. I am conducting surveys about how the COVID-19 pandemic has affected day-to-day use of the Montreal Metro. I'm conducting this as part of research for my undergraduate thesis in the Department of Geography at McGill University. I'm working under the direction of my supervisor Professor Kevin Manaugh. I'm inviting you to do a one-on-one interview that will take about 5 minutes. I will ask about your experience choosing transportation, the purpose of your trips, and your perceived safety on the Metro during the COVID-19 pandemic. I will take handwritten notes to record your answers. It is not likely that there will be any serious harms or risks associated with your participation. There will be no direct benefit to you by participating. Your identity will remain anonymous. The data you provide may be used in my thesis paper, which may be published publicly. If you have any questions or concerns regarding your rights or welfare as a participant in this research study, please contact the McGill Ethics Officer at 514-398-6831 or lynda.mcneil@mcgill.ca . My McGill email is zachary.beresin@mail.mcgill.ca, and my supervisor's email is kevin.manaugh@mcgill.ca. Your participation is voluntary, and you are free to stop at any time. Do you have any questions or would you like any additional details? Do you agree to participate in this study?

APPENDIX F: Interview Informed Consent Sheet (General Population)

McGill

Informed Consent Form

Undergraduate Student Honours Thesis Research Project for
McGill University Department of Geography

'Investigating the Effects of COVID-19 on the Operations of and Use of the Montreal Metro' - Research Ethics Board file number 21-08-044

Student Name: Zachary Beresin

Description: I am an undergraduate student from the Department of Geography at McGill University. I am using fieldwork techniques to explore how the COVID-19 pandemic has affected the day-to-day operations of and use of the Montreal Metro. I invite you to be interviewed for my research project – remotely on McGill Microsoft Teams – which aims to assess the public perception of personal safety traveling on the Metro. Using my findings I will write a research paper to contribute to existing literature on these topics.

Questions will cover topics such as modes of transportation taken, purpose of trips, and safety on public transport during the COVID-19 pandemic. The results will be used for my thesis paper and may be used in published work.

Recording: I ask permission to take an audio recording of our interview in order to take more accurate notes. You are free to refuse permission and we can proceed without the recording. If you do consent, our conversation will be digitally recorded. You may keep your camera turned off during the interview, if you wish. Only I will have access to the digital file, which will be kept on a password protected computer for seven years. A written transcript of the interview – without your name – and a key with your name (separate file) and your signed consent form will be kept for seven years on a password protected computer, in separate password protected computer files.

Time Involvement: The interview will take approximately 30 minutes.

Risks and Benefits: Your name will remain confidential and will not be used in my final written report. There are no foreseeable risks to you associated with your participation. Further, despite all precautions taken, there is a small chance of interception of any data collected via the internet. For your participation, you will be entered into a drawing for $50 along with other research participants.

Your Rights: You are under no obligation to participate, you may end the interview at anytime, and you may withdraw at any time or refuse to answer any question.

Questions or concerns? If you have any questions or concerns regarding your rights or welfare as a participant in this research study, please contact the McGill Ethics Officer at 514-398-6831 or lynda.mcneil@mcgill.ca. Further, my McGill email is zachary.beresin@mail.mcgill.ca, and my supervisor Professor Kevin Manaugh's email is kevin.manaugh@mcgill.ca.

Skill Test: Please answer the following question to be legally entered for the $50 draw

(3x10) - (4x4)

= _____

I give consent to be audiotaped during this interview.
Please initial: ___Yes ___No

I, [print name] _____ hereby agree to participate in this research and am aware that my data will remain confidential, there are no foreseeable risks associated with this research, and that I will only be eligible for a drawing of $50 compensation upon completion of the interview.

Signature: _____ Date: _____

Thank you for being willing to be involved in my research project!
Student to provide a copy of this consent form for the participant to keep.

APPENDIX G: Interview Informed Consent Sheet (STM Official)

McGill

Informed Consent Form

Undergraduate Student Honours Thesis Research Project for
McGill University Department of Geography

'Investigating the Effects of COVID-19 on the Operations of and Use of the Montreal Metro' - Research Ethics Board file number 21-08-044

Student Name: Zachary Beresin

Description: I am an undergraduate student from the Department of Geography at McGill University. I am using fieldwork techniques to explore how the COVID-19 pandemic has affected the day-to-day operations of and use of the Montreal Metro. I invite you to be interviewed for my research project – remotely on McGill Microsoft Teams – which aims to assess COVID-19 resilience and public perception of personal safety on public transportation. Using my findings I will write a research paper to contribute to existing literature on these topics.

Questions will cover topics such as safety measures enacted during the COVID-19 pandemic, plans for future operations, and ridership trends. The results will be used for my thesis paper and may be used in published work.

Recording: I ask permission to take an audio recording of our interview in order to take more accurate notes. You are free to refuse permission and we can proceed without the recording. If you do consent, our conversation will be digitally recorded. You may keep your camera turned off during the interview, if you wish. Only I will have access to the digital file, which will be kept on a password protected computer for seven years. A written transcript of the interview – without your name – and a key with your name (separate file) and your signed consent form will be kept for seven years on a password protected computer, in separate password protected computer files.

Time Involvement: The interview will take approximately 30 minutes.

Risks and Benefits: Your name will remain confidential and will not be used in my final written report. There are no foreseeable risks to you associated with your participation. Further, despite all precautions taken, there is a small chance of interception of any data collected via the internet.

Your Rights: You are under no obligation to participate, you may end the interview at anytime, and you may withdraw at any time or refuse to answer any question.

Questions or concerns? If you have any questions or concerns regarding your rights or welfare as a participant in this research study, please contact the McGill Ethics Officer at 514-398-6831 or lynda.mcneil@mcgill.ca. Further, my McGill email is zachary.beresin@mail.mcgill.ca, and my supervisor Professor Kevin Manaugh's email is kevin.manaugh@mcgill.ca.

I give consent to be audiotaped during this interview.
Please initial: ___Yes ___No

I, [print name] _____ hereby agree to participate in this research and am aware that my data will remain confidential, there are no foreseeable risks associated with this research.

Signature: _____ Date: _____

Thank you for being willing to be involved in my research project!
Student to provide a copy of this consent form for the participant to keep.

APPENDIX H: Resource List for Participants

Tel-Aide : 514-935-1101 - Free, anonymous, non-judgmental listening centre for people in distress. Operates 24/7.

Hope for Wellness Helpline : 1-855-242-3310 / chat (available on the website) - 24/7 Immediate mental health counseling and crisis intervention to all Indigenous peoples across Canada, available in Cree, Ojibway and Inuktitut (upon request), with experienced and culturally competent counsellors.

For immediate assistance call 911