UNIVERSIDADE DE LISBOA

INSTITUTO SUPERIOR TÉCNICO

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Impact of interventions in preschools of São Paulo (Brazil)

Mateus Humberto Andrade

Supervisor: Doctor Filipe Manuel Mercier Vilaça e Moura

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Thesis approved in public session to obtain the PhD Degree in

Transportation Systems

Jury final classification: Pass with Distinction and Honour

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2021

Ensinamento

Minha mãe achava estudo
A coisa mais linda do mundo.
Não é.
A coisa mais linda do mundo é o sentimento.
Aquele dia de noite, o pai fazendo serão,
ela falou comigo:
"Coitado, até essa hora no serviço pesado."
Arrumou pão e café, deixou tacho no fogo com água quente.
Não me falou em amor.
Essa palavra de luxo.

Adélia Prado, Poesia Reunida (1991)

Agradecimentos (in Portuguese)

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Abstract

This doctoral thesis seeks to **evaluate the effects of school-based interventions on changing the travel behavior of preschool-age children and their caregivers** following the implementation of a 4-month school-based program focused on: i) exploring the open public space in the surroundings of schools through walking and ii) inquiring children about urban mobility through the "Philosophy with Children" (PwC) participatory approach. The empirical research project was implemented together with 5 to 6-year old children and their caregivers from public preschools in São Paulo (Brazil) with a high prevalence of low-income immigrants, between February and August 2019.

To achieve the overarching objective and its associated research questions, an Action Research is proposed using a mixed methods approach, whose selection criteria are largely based on the Capability Approach. In the selected schools, two different strategies aiming at changing the travel behavior of children and their caregivers are evaluated, whose primary and secondary data collected are assessed using a set of data analysis approaches.

In the measurement of the collective capabilities and functionings of preschools in São Paulo under the Capability Approach, the conditions to access schools through walking were assessed using georeferenced datasets relating to mobility, road safety, and the built environment. The schools were analyzed according to their conditions to walk (resources) and the corresponding conversion rates to achieve higher shares of pedestrian trips (functionings), considering the idiosyncrasies between public and private schools. These procedures enabled the estimation of the mobility capabilities, which presented gaps when compared with the functionings. Results corroborated with the class and race disparities in the access to education in Brazil, in which schools with poorer conditions to walk do not have any other options than walking to access school (*e.g.* transit or bicycle), requiring investments in the upgrading of the urban infrastructure. On the other hand, schools in wealthier regions present barriers to the fulfillment of active mobility even when the resources are considered sufficient, in which the implementation of educational programs is recommended. The metrics obtained from the Capability Approach also supported the selection of three public schools with similar levels of mobility resources.

The empirical results of the academic research implemented in the selected public preschools enabled the adoption of a set of qualitative analysis tools to extract children's views and perceptions about urban mobility, namely topic modelling (Latent Dirichlet Allocation) and sentiment analysis (AFINN and Bing sentiment lexicons). These allowed the identification of

variables affecting the opinions about urban mobility shared by young children (5-6 y/o.), including more negative perceptions among boys, non-native children, and those in high social vulnerability.

Finally, the evaluation of changes in the travel behavior of young children and their caregivers fostered the observation of positive changes in the perceptions of children's statements and in the social norms of their caregivers about transportation. Similarly, the proposed strategies to promote changes in travel behavior promoted significant modal shifts towards sustainable mobility as reported by the caregivers. The observed changes were evaluated using difference-in-differences and time-series analyses. Besides the identification of changes in the behavior of adult caregivers through child-centered intervention types, the empirical research presented unraveled the effect of the proposed interventions according to the child's gender, nationality, and level of social vulnerability, which were significant both in measures collected immediately after the intervention types (post) and in the follow-up measurements. In addition to providing an evaluation of school-based interventions with data from a Global South country, the discussions presented in this thesis intend to provide insights into the role of early childhood and children's perceptions in behavioral changes towards sustainable transport.

Keywords: Early childhood; Active transport; Behavior change; Global South; Action Research.

Resumo (in Portuguese)

Esta tese de doutoramento busca **avaliar os efeitos de um conjunto de intervenções em escolas na mudança de comportamento de crianças em idade pré-escolar e de seus cuidadores em relação à mobilidade urbana**, em seguida à implementação de um programa de 4 meses centrado em: i) explorar o espaço público nos arredores das escolas por meio da caminhada e ii) indagar as crianças sobre mobilidade urbana por meio da abordagem participativa da "Filosofia com Crianças". O projeto de investigação empírica foi implementado junto a crianças de 5 a 6 anos de idade e seus cuidadores em escolas de educação infantil de São Paulo (Brasil) com grande incidência de imigrantes de baixa renda, entre fevereiro e agosto de 2019.

A fim de atingir o objetivo global e as perguntas de investigação associadas, propõe-se uma investigação-ação utilizando uma abordagem de métodos mistos, cujos critérios de seleção baseiam-se largamente na Abordagem das Capacitações (*Capability Approach*). Nas escolas selecionadas, são avaliadas duas estratégias diferentes que visam alterar o comportamento das crianças e dos seus cuidadores com relação à mobilidade urbana, cujos dados primários e secundários recolhidos são avaliados utilizando um conjunto de ferramentas de análise de dados.

Na medição das capacitações (*capabilities*) e dos funcionamentos (*functionings*) das escolas em São Paulo sob a Abordagem das Capacidades, as condições de acesso às escolas por meio da mobilidade a pé caminhada foram avaliadas utilizando um conjunto de dados georreferenciados referentes à mobilidade, à segurança rodoviária e ao ambiente construído. As escolas foram analisadas de acordo com as suas condições para caminhar (*resources*) e as correspondentes taxas de conversão (*conversion factor*) para alcançar maiores parcelas modais de viagens a pé (*functionings*), considerando as idiossincrasias entre escolas públicas e privadas. Essas operações permitiram estimar as capacitações de mobilidade (*capabilities*), que apresentaram lacunas quando comparadas com os funcionamentos (*functionings*). Os resultados corroboraram as disparidades de classe e raça no acesso à educação no Brasil, em que as escolas com piores condições para andar a pé não possuem outras opções para além do modo a pé para acessar as escola (por exemplo em bicicleta ou transporte público), exigindo assim investimentos na melhoria da infra-estruturas urbana. Por outro lado, as escolas em regiões mais abastadas apresentam barreiras à realização da mobilidade ativa, mesmo quando os recursos são considerados suficientes, em que se recomenda a implementação de programas de educação e *marketing*. As métricas obtidas a partir da Abordagem das Capacitações também serviram para embasar a seleção de três escolas públicas com níveis semelhantes de condições para caminhar (*resources*).

Os resultados empíricos da investigação académica implementada nas escolas públicas selecionadas permitiram a adoção de um conjunto de ferramentas de análise qualitativa para extrair as opiniões e percepções das crianças sobre mobilidade urbana, nomeadamente a modelação de tópicos (Latent Dirichlet Allocation) e a análise de sentimentos (léxicos AFINN e Bing). Essas ferramentas permitiram a identificação de variáveis que parecem influenciar as opiniões sobre a mobilidade urbana partilhadas por crianças pequenas (5-6 anos de idade), incluindo percepções mais negativas entre meninos, crianças não nativas e aquelas sob elevada vulnerabilidade social.

Por fim, a avaliação das mudanças no comportamento das crianças pequenas e dos seus cuidadores em relação à mobilidade urbana possibilitou a observação de mudanças positivas nas falas das crianças e nas normas sociais dos seus cuidadores sobre o transporte. De forma similar, as estratégias propostas promoveram migrações modais significativas em torno da mobilidade sustentável conforme relatadas pelos cuidadores, que foram avaliadas utilizando análises de diferenças-nas-diferenças (*difference-in-differences*) e séries temporais (*time-series analysis*). Para além da identificação de mudanças no comportamento dos cuidadores adultos através de intervenções centradas na infância, a investigação empírica apresentada permitiu desvendar o efeito das intervenções propostas de acordo com o género, nacionalidade e nível de vulnerabilidade social da criança, o que foi significativo tanto nas medidas coletadas logo após as intervenções (*post measures*) quanto no acompanhamento das intervenções (*follow-up measures*). Além de fornecer uma avaliação das intervenções em escolas com dados de um país do Sul Global, as discussões apresentadas nesta tese pretendem fornecer uma visão do papel relevante da primeira infância e das percepções das crianças sobre mudanças comportamentais em torno de uma mobilidade mais sustentável.

Palavras-chave: Primeira infância; Transporte ativo; Mudança comportamental; Sul global; Investigação-Ação.

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List of abbreviations

AR	Action Research
AT	Active Transport
CA	Capability Approach
HDCA	Human Development and Capability Association
IMT	Individual Motorized Transport
LDA	Latent Dirichlet Allocation (model)
LR	Linear Regression (model)
MT	Motorized Transport
OD	Origin-Destination (survey)
OLS	Ordinary Least Squares (regression model)
PT	Public Transport
PwC	Philosophy with Children (inquiry approach)
RQ	Research Question
y/o.	Years old (age)

1. Introduction

Home-school trips made by children and youth represent a significant share of daily trips in several parts of the world. However, many countries have registered a decline in children's active and independent mobility in the last decades, which is undesirable for building safe, sustainable, and inclusive cities (Fyhri et al., 2011a). Moreover, measures aiming at changing behavior towards sustainability have found increased opposition not only in the public sector (from municipalities to the national government), but also in civil society (citizens, corporations and social movements), with important decision makers increasingly overlooking the impacts of unsustainable transport on climate change, public health and socio-spatial disaggregation (Martens, 2017; Richter et al., 2010).

Education has been identified as a major factor for inducing changes in travel behavior towards territorial equity (Martens, 2017; Mullen, 2012), as well as the right to live in sustainable cities, to use clean transport modes and to have good access to relevant destinations.

The field of childhood development has acquired major significance in transportation mostly after the impacts of primary education on the travel behavior were acknowledged, indicating a more significant impact than similar programs with adults (Sirard and Slater, 2008; E. O.D. Waygood et al., 2017). Many authors have researched about the relationship between transport and child well-being and regarding the correlates of walking and bicycling to school, which highlighted the role of several variables to affect active mobility with children and effects of transport on children's well-being (Grannis, 2009; E.O.D. Waygood et al., 2017). These allowed for the recognition of relevant patterns regarding the interventions to promote specific mobility habits in a permanent way, as well as the negative effect of segregated neighborhoods and car use on the well-being of both children and adults (Sidharthan et al., 2011).

The potential of including child development in transport measures seems nonetheless to be much broader than the scope of current research on health, well-being, and children's transportation, since previous research has tended to neglect how transportation might influence children's perceptions and social interactions (E. O.D. Waygood et al., 2017). Together with the claim for active mobility, the issue of children's independent mobility, *i.e.* when children have the freedom to travel without adult supervision (Larsen et al., 2015), has been fundamental in developing measures aimed at reducing traffic fatalities (Rothman et al., 2017), shifting from car use to walk and bike (McDonald, 2008), promoting physical activity and social interactions (Westman et al., 2016), enhancing the public realm (O'Brien et al., 2000), and consolidating communities and geographies (Horton et al., 2014).

Previous research has identified many benefits in transportation brought by travel behavior interventions with children in schools, including increases in children's physical activity and active commuting (Xu et al., 2015; Tymms et al., 2016; Verhoeven et al., 2016). However, it has tended to disregard younger children below 8 years old and the case of low-income communities, especially in the Global South (Porter and Abane, 2008). These issues involving marginalized populations have been increasingly discussed in the context of transportation equity, whose questions "involve both sufficientarian and egalitarian concerns with both absolute levels of wellbeing, transport-related poverty and social exclusion as well as with relative levels of transport-related inequalities" (Pereira and Karner, *forthcoming*). Furthermore, there is still much to be researched on the interaction between people's perceptions and the reported travel behavior, mainly related to participatory approaches to incorporating children's voices and the impact assessment of child-centered interventions on adults. Finally, there is a limited number of studies evaluating the interplay between different types of interventions, including the differential impact of outdoor and in-classroom interventions on the effectiveness of such programs.

1.1. Objectives and research questions

The overarching goal of this research is to **evaluate the effects of school-based interventions on changing the travel behavior of preschool-age children and their caregivers**, focusing on active mobility and using mixed-method empirical Action Research in public schools from a Global South country. To achieve this, three key research questions were formulated (Table 1).

Table 1: Doctoral research's key research questions (K-RQ).

Key Research questions (K-RQ)	
K-RQ1	How can we capture and understand the way mobility capabilities enable the different mobility functionings in early childhood?
K-RQ2	How can we incorporate the views and perceptions of preliterate younger children into travel behavior research?
K-RQ3	Do specific interventions in schools affect the travel behavior of children and caregivers in the short term?

The key research questions seek to address the overarching objective of the doctoral research by incorporating the work of Nobel laureate Amartya Sen on the Capability Approach using mixed method empirical approaches, including capturing the perceptions and social norms

of young children (5-6 years old) and their caregivers regarding the use of transport modes. In order to respond to the key research questions, five specific objectives were set, as follows (Table 2).

Table 2: Doctoral research's specific research objectives associated with key research questions (K-RQ).

K-RQ	**Specific objectives**	
K-RQ1	S-O1	Prospect the variables that indicate the degrees of mobility capabilities and functionings of children and their caregivers
	S-O2	Develop compounded indicators of mobility capabilities and functionings of schools, focusing on active modes
K-RQ2	S-O3	Develop, test and implement a method to capture the views and perceptions of preliterate younger children about urban mobility
K-RQ3	S-O4	Monitor the implementation of a selected intervention in schools regarding the promotion of active mobility capabilities of children and their caregivers
	S-O5	Assess the correlates of short-term changes in the travel behavior of children and their caregivers due to school-based interventions

The context of this work refers to the preschools in São Paulo (Brazil), i.e. children up to six years old and their caregivers (parents and guardians), whose characterization, data and related methodological steps are described in section *3. Methodology* and further details are presented in the following sections containing the main results and research outputs (sections 4, 5 and 6). Furthermore, with the aim of responding to the specific research objectives previously presented, a research roadmap was built by associating the specific objectives to a set of specific research questions, as presented in Table 3.

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Table 3: Research roadmap associating the specific research questions to the specific objectives.

Specific objectives	**Specific research questions**
S-O1. Variables indicating the mobility capabilities of children and caregivers	S-RQ1. How can the Capability Approach be integrated into the domain of mobility behavior analysis?
	S-RQ2. Can a 'mobility capability' and 'mobility functioning' be quantitatively observed?
	S-RQ3. What variables might indicate the degrees of mobility capability and mobility functioning of children and their caregivers?
S-O2. Indicators of mobility capabilities and functionings of schools	S-RQ4. What variables define the mobility capabilities of preschoolers within an urban area? Which of them regard data on the surroundings of schools (*e.g.* coverage of sidewalks)?
	S-RQ5. What is the adequate scale of aggregation (*e.g.* buffer size and extent of service area around schools) of data on the surroundings of schools?
	S-RQ6. How can capability metrics be aggregated into a compound indicator focusing on active mobility?
	S-RQ7. Are there relationships between the capability indicators and the mobility functionings? If so, how are they related?
	S-RQ8. Can the capability indicators be evaluated in terms of potential to promote mobility functionings? Can they guide the selection of appropriate sites for data collection?
S-O3. Method to capture perceptions of younger children about urban mobility	S-RQ9. How can we develop and test a method to capture the views and perceptions of younger children about urban mobility?
	S-RQ10. What are the available methods for analyzing large qualitative datasets collected with younger children in a structured way?
S-O4. Monitoring of selected interventions regarding the promotion of active mobility capabilities	S-RQ11. How can the collected data from children and their caregivers be associated and analyzed?
	S-RQ12. Which are the existing interventions seeking to promote mobility capabilities with children? How are the caregivers involved? How are their evaluation methods like?
	S-RQ13. Which are the available methods for assessing changes in the travel behavior of children and their caregivers following a school-based intervention?
S-O5. Correlates of travel behavior change due to school-based interventions	S-RQ14. What are the correlates of mobility capabilities of children and their caregivers? What are the correlates of active transport to school? Are these related?
	S-RQ15. What are the perceived changes in the travel behavior of children and their caregivers due to the selected interventions in schools?

With the purpose of looking for consistency of the work presented in this thesis, the objectives and research questions established are revisited throughout the thesis, being associated with the literature review (section 2), with the main results and research outputs of the empirical work conducted (sections 4, 5 and 6) and in the concluding remarks of the thesis (section 7).

1.2. Contribution of research

The empirical contribution of this work is expected to encourage the intersection of scientific domains such as transportation, urban studies, social justice, education, social psychology, and childhood studies, in which a transdisciplinary understanding is increasingly required. This doctoral research and the answers to the aforementioned research questions are expected to contribute to the existing theory and practice in travel behavior research, including:

- The adoption of the Capability Approach in the measurement of inequalities in urban mobility and childhood development;
- The suitability of the "Philosophy with Children" approach to enquire preliterate younger children about their established behavior and to incorporate children's voices into urban planning;
- The analysis of large qualitative datasets to support travel behavior research through text mining techniques, e.g. topic modelling and sentiment analysis;
- Evaluation of child-centered interventions, particularly with regard to the role of perceptions, early childhood development, and the child-caregiver relationship in behavioral changes involving school-based strategies.

The outcomes of this doctoral research, including those from parallel research with relevant contributions to this thesis, have appeared in or were submitted to peer-reviewed publications and conferences, as well as through examination boards and in research outreach. The contributions directly related to the topic of this doctoral thesis is presented in Table 4.

Table 4: Summarized contributions with direct association to the doctoral thesis, in reverse chronological order (2017-2020). * Accepted extended abstract, but no conference attendance.

Type of contribution	Date	Institution / Journal	Contribution title (if available)
Peer-reviewed publications	-	Travel Behaviour and Society	Incorporating children's views and perceptions about urban mobility (submitted February 2020)
	Jan/2021	Journal of Transport Geography	Can outdoor activities and inquiry sessions change the travel behavior of children and their caregivers? Empirical research in public preschools in São Paulo (Brazil)
	Mar/2020	Journal of Human Development and Capabilities	Investigating the Mobility Capabilities and Functionings in Accessing Schools Through Walking
	Jun/2019	Praxis & Saber	Displacements and philosophy: a study on movement and space perceptions involving children
Other publications (non peer-reviewed)	Dec/2018	Associação Nacional de Transportes Públicos (Brazil)	O acesso das crianças às escolas em São Paulo Avaliação quantitativa de creches e pré-escolas com foco na mobilidade a pé (research article)
	Aug/2017	LABMOB/UFRJ (Brazil)	Gênero e andar a pé: a qualidade do ambiente construído incentiva igualmente mulheres e homens a caminhar? (book chapter)
Conferences	Jul/2019	XIX ICPIC Biennial Conference (Colombia)	Desplazamientos y filosofía: estudio sobre las percepciones de espacio y de movimiento con niños pequeños
	May/2019	9º Congresso Rodoviário Português (Portugal)	Mudança para a mobilidade sustentável na infância: uma avaliação dos impactos das campanhas "a Serpente Papa-Léguas" nas escolas primárias portuguesas
	Out/2018	MIT Portugal 2018 Conference (Portugal)	Conditions of access to preschools and nurseries in São Paulo (Brazil)
	Aug/2018	2018 HDCA Conference (Argentina)	Investigating the mobility capabilities and functionings of children and their caregivers
	Jul/2018	2018 International Conference on Travel Behavior Research (USA) *	Shifting towards sustainable mobility in childhood: an assessment of the impacts of the "Traffic Snake Game" campaigns in Portuguese primary schools
	May/2017	2017 RedeMOV Conference (Portugal)	The role of public schools to promote transport policies towards active modes
Research outreach	Dec/2018	HDCA (web-based)	Work in progress on developing measures using the Capability Approach (webinar)
	May/2018	Univ. of Oxford (UK)	Quantitative assessment of public and private schools in São Paulo (Brazil) regarding the access through public school bus (poster/workshop)

1.3. Thesis outline

This doctoral research is composed by sections that seek to address the overarching objective of *evaluating the effects of school-based interventions on changing the travel behavior of children and their caregivers* and its associated research questions, sub-objectives and specific research questions. This was predominantly achieved through the drafting of three research articles that were submitted to peer-reviewed journals between September 2018 and June 2020.

In section *2.Literature Review* three main topics are covered by reviewing the existing scientific literature: i) issues of measurement under the Capability Approach regarding the conditions of children to access schools; ii) methods for incorporating children's views and perceptions about urban mobility; and iii) impact evaluation of school-based interventions on the travel behavior of both children and their caregivers.

Section *3. Methodology* discusses Action Research as a theoretical perspective and the role of the Capability Approach to select appropriate schools for data collection, That is followed by the description of strategies that were implemented to promote travel behavior changes and the approaches for collecting and analyzing data together with schools, children and their caregivers.

In sections 4, 5 and 6, an adapted and summarized version of the research articles submitted is presented, providing a detailed description of the data collected, the methods adopted, and the main results obtained throughout the doctoral research. These manuscripts are either published or under review by peer-reviewed publications and cover the issues regarding i) the measurement of mobility capabilities and functionings under the Capability Approach; ii) the incorporation of children's views and perceptions about urban mobility; and iii) the impact evaluation of the proposed interventions in children and caregivers on their travel behavior.

Finally, section *7. Conclusion* presents the main topics for discussion of the research project undertaken, in which the research questions are revisited and the limitations and possible avenues for future research are identified.

2. Literature Review

In the last decades, much has been written about the role of urban mobility to achieve social justice. However, changes in public policies towards territorial equity have found increased opposition not only in the public sector (from municipalities to the national government), but also in civil society (citizens, corporations and social movements), with important decision-makers increasingly overlooking the impacts of transport on climate change, public health, and socio-spatial disaggregation, among others (Martens, 2017; Richter et al., 2010). In this sense, public agencies and advocacy-led organizations have identified in schools a set of relevant factors to increase the right to the city through the promotion of permanent changes in transport practices. These refer mainly to the initiatives regarding the promotion of active mobility, which involves walking or cycling to relevant destinations, including schools and other educational facilities (Veitch et al., 2017).

In this section, the issue of travel behavior research in childhood and youth is presented, especially in relation to young children, where the Capability Approach is shown to be an appropriate tool for the examination of socio-spatial inequalities, the quest for methods to incorporate children's voices becomes imperative, and the acknowledgement of the approaches seeking to change children's behavior towards sustainable mobility is a key element.

One can identify several commonalities of the Capability Approach (CA) with topics on the generation and inducement of demand in transportation, such as the intersection of the underlying claim of asking "what people are able to do and what lives they are able to lead" under the Capability Approach (Robeyns, 2017) with the need for understanding the travelers' responses to transportation policies through a more behavioural-oriented approach (Van Acker et al., 2010). Also, there are prevalent features between the CA's focus on the individual's capability that enable people to achieve relevant functionings from their own capability sets (Robeyns, 2017) and the conceptual framework that seeks to understand latent travel demand (Clifton and Moura, 2017), which are consistently overlooked. The emphasis on active mobility set in this work is grounded on the relevance of walking, cycling, and other active modes of transport to combine themes of equity and social exclusion, many times disregarded in transportation studies (Lucas et al., 2016; Martens, 2012; van Wee and Geurs, 2011).

Besides the relevant contribution from the Capability Approach to grasp the deprivations of children, which have been regularly "overlooked by analyses that focus on the household unit" (Alkire, 2008, p. 35), the intersection of the proposed transportation studies with the Capability Approach's domains of economics, philosophy and education seems adequate to grasp the mobility behavior of children. The CA provides contributions on both egalitarian and sufficientarian concerns discussed in the transport literature (Lucas et al., 2016; van Wee and

Geurs, 2011) by searching for "the definition of a list of [culture-dependent] basic capabilities and minimum thresholds" (Pereira et al., 2017). Furthermore, the CA's emphasis on realized and potential functionings "provide an opportunity for new conceptualizations of children's independent and active travel" (Babb et al., 2016). Alongside the traditional objective approach incorporated in some way in the concept of *mobility functionings*, the CA provides through its concept of *capabilities* a compelling analysis of one's potential to achieve valuable activities, which somehow are not accomplished.

By focusing on walking and its intersection with the quality of the built environment, some authors identified the significance of promoting walking in the open public space regarding i) the alleviation of children's and caregivers' accessibility shortages (Babb et al., 2016; Sirard and Slater, 2008); ii) the change of transport habits towards territorial equity (Pereira et al., 2017); and iii) the development of core skills for children that are activated through walking and staying in the public space, such as the social and cognitive capacities (Shonkoff and Phillips, 2000; Waygood and Cervesato, 2017).

Although the Capability Approach is widely applied across disciplines, there is still a limited body of publication seeking to operationalize the CA metrics within the domain of urban mobility and the collective setting of schools. In this sense, it is relevant to look for the correspondences of the CA with pertinent aspects concerning the daily mobility of children, especially the ones regarding the access to relevant destinations through walking. Contributions on the intersection of these topics are still scarce, in which little attention was given to the potential of the CA for understanding children's well-being (Biggeri and Libanora, 2011; Leßmann, 2016). These topics are further explored in the following section *2.1. Children's travel behavior through the Capability Approach*.

Regarding the incorporation of children's voices in travel behavior research, the opinions of children have been commonly disregarded in previous research (Friman et al., 2020; Noonan et al., 2016; Zwerts et al., 2010), which has "been limited to singular qualitative methods that overlook children's varied linguistic ability and interaction preference" (Noonan et al., 2016). Moreover, children are commonly seen as "being unable to make (sensible) decisions for themselves" (Mitchell et al., 2007). Especially in a context in which children are being increasingly deprived from autonomy due to the "prevalent social construction of children as dependent" and the "appearance of good parenting" (Mitchell et al., 2007), it seems imperative to undertake a deeper analyses of the approaches that seek to incorporate children's views and voices into transport planning, which is explored in more detail in section *2.2. Incorporation of children's views on urban mobility*.

Finally, the literature on the intervention studies covering children and teenagers is still in an early stage in transport studies (Schönbach et al., 2019), which underscores a need for stronger study designs in this area of research (Larouche et al., 2018). These studies are commonly embedded with the belief that "reducing this dependence [of auto transportation] at an early age may establish a lifelong pattern of active transportation" (Sirard et al., 2015, p. 29). Empirical studies addressing behavioral changes in children's transport include a variety of programs that seek to increase children's active commuting to school and decrease traffic congestion, including a set of well-established programs such as the Walking School Bus (Mendoza et al., 2011; Sayers et al., 2012) and the school travel plans (Hinckson and Badland, 2011), as well as other school-based initiatives such as cycle training courses (Ducheyne et al., 2014) and physical activity interventions (Christiansen et al., 2014). This literature nonetheless seems to present a substantial heterogeneity and low quality of evidence across studies (Larouche et al., 2018), which is further explored in section *2.3. Travel behavior change through interventions with children*.

2.1. Children's travel behavior through the Capability Approach

The Capability Approach (CA) was first introduced in 1979 by Indian economist Amartya Sen as "an intellectual discipline that gives a central role to the evaluation of a person's achievements and freedoms in terms of his or her actual ability to do the different things a person has reason to value doing or being" (Sen, 1979),. The CA enables therefore viewing people not only as the center but also as the main agents of development (Ibrahim, 2017), which provides a conceptual framework for a range of evaluative exercises, including the assessment of social arrangements and institutions. According to Philosopher Martha Nussbaum (2007), the Capability Approach purports that "freedom to achieve wellbeing is a matter of what people are able to do and to be, and thus the kind of life they are effectively able to lead" (Nussbaum, 2007).

The CA approach entails two basic concepts, *capabilities* and *functionings*, which despite being intimately connected provide independently useful concepts. The conceptualization of *functionings* and *capabilities* can be framed as "an individual's actual and potential activities and states of being, respectively" (Kuklys, 2005), being capabilities "a vector of achieved functionings (…), a collection of functionings a person can achieve", and functionings understood as "integral elements of capabilities" (Alkire, 2008).

In other words, through its two basic concepts (capabilities and functionings), the CA seeks to enquire "what people can do and be (their capabilities) and what they are actually achieving in

terms of beings and doings (their functionings)" (Robeyns, 2017). Some challenges in the quantitative empirical literature on the capability approach can be nonetheless identified, such as the selection and measurement of the relevant functionings (*e.g.* riding a bicycle, the effective mobility habits), the aggregation of these functionings into a composite measure of individual welfare (*e.g*. being able to ride a bicycle, the capability to perform several mobility functionings) and the aggregation of individual welfare to social welfare (*e.g.* composite indicators of mobility or accessibility) (Kuklys, 2005).

The Capability Approach has been considered a "yardstick for the evaluation of prosperity and progress" in several fields, from applied ethics to quantitative empirical stands (Robeyns, 2017). In a recent review on distributive justice and equity in transportation, the potential of Sen's Capability Approach to address different dimensions of transport exclusion and inequalities was recognized, as well as its appropriateness to grasp interpersonal differences in accessibility levels (Pereira et al., 2017). For the application of the CA to transport policy, Pereira and colleagues (2017) emphasize the need for coupling "accessibility needs with the idea of social rights insofar as some minimum level of accessibility is necessary for the satisfaction of individuals' basic needs", such as going to school and receiving healthcare. Furthermore, they point out the relevance of raising a discussion on "the identification of minimum acceptable thresholds of accessibility to key activities", which remains unresolved in the academic literature (*Ibid.*). The search for alternative methods for assessing the autonomy of groups and individuals concerning choice and decision making resonates with McFadden's critique on the utilitarian approaches, in which he places fairness as a "primary concern" and efficiency as "someone else's problem" (McFadden, 2006, p. 6).

The Capability Approach, as viewed by Sen, refrains the formulation of a list of basic capabilities "that applies to all the different purposes for which the capability approach can be used" (Robeyns, 2017), to which a set of features related to transportation and mobility could possibly belong. This is influential when drafting applications based on the Capability Approach, which "will always require a *selection of valuable functionings* that fit the purpose of the theory or application" (*Ibid.*, emphasis added). A strong critique is voiced by Martha Nussbaum (Nussbaum, 2007), who follows Sen's account of primary goods to defend a list of ten central human capabilities "towards basic political principles", from which four are highlighted in Table 5 to indicate the association with the mobility capabilities into the domain of active mobility and childhood (*Ibid.*).

Table 5: Four selected human capabilities, respective descriptions (extracted from Nussbaum, 2007), and proposed translation into the domain of active mobility and childhood.

Central human capabilities	**Description**	**Proposal of translation into the domain of active mobility and childhood**
Control over One's Environment	Active citizenship and rights of political participation life, directly within the conception.	Autonomous access to valuable destinations through metabolic (non-motorized) modes, which exempts the supervision and/or driving by adults.
Practical Reason	Capacity to frame goals and projects and to plan one's life, which requires opportunities for a variety of activities and plenty of room to move around.	Possibility of performing a variety of activities at liberty of direction and available routes, regardless of escorts, location or condition.
Affiliation	Ability to live with and toward others.	Capability of dealing with unspecified quantity of persons through moving (and stopping) in public space.
Play	Protection of adequate space, light, and sensory stimulation in living places, and, above all, the presence of other children and adults	Entitlement to interact with actual conditions of the living environment through a wide range of demeanors, such as move, play, labor, and contemplation.

The suitability of the presented "list of capabilities" to the domain of urban mobility is therefore remarkable: the acknowledgement of "room to move around" and the "ability to live with and toward others" to yield basic human capabilities are some of the aspects of Nussbaum's capabilities list that are directly related to the issues within the mobility domain. When specifically regarding the promotion of capabilities from childhood onwards, the recognition of play, affiliation and control "within the conception" is thus critical for grasping the effects of mobility policy measures on children under the Capability Approach, either integrating a predetermined list of capabilities or selecting "valuable functionings" that fit specific applications of the CA.

The intersection of urban transport with CA-based research and the search for the concepts of "mobility capabilities" and "mobility functionings" does not lack nonetheless foundations within the CA framework. One can identify several commonalities with topics on the generation and inducement of demand in transportation, such as the intersection of the basic claim of asking "what people are able to do and what lives they are able to lead" under the Capability Approach (Robeyns, 2017) with the need for understanding the travellers' responses to transportation policies through a more behavioral-oriented approach (Van Acker et al., 2010). Similarly, the CA's "focus both on the individual's capability set and also on what people have been able to realize from their own capability sets" (Robeyns, 2017) seems convergent with the "conceptual framework for understanding latent [travel] demand" proposed by Clifton and Moura (2017).

In addition, the issue of active commuting (pedestrian and cycling), school transportation, and social justice seems to be a well-established topic in the transport literature (*cf.* Kerr et al., 2006; Mitra, 2013; Schoeppe et al., 2013), which might support the identification of variables that encourage or hinder the access to schools by children through walking, even though these studies are more commonly found in the Global North. In an extensive review of papers on the correlates of walking and bicycling to school, Sirard and Slater (2008) identify a set of variables at the neighborhood level that are correlated with higher walking and cycling rates to school, such as the role of densely populated neighborhoods and the existence of sidewalks to promote active modes of transport, also highlighted in recent publications in the field of urban transportation (Vale et al., 2016). The issue of children walking to school seems therefore to resonate with the empirical applications of the CA such as the ICF survey (International Classification of Functioning, Disability and Health), which provides a set of mobility-related capabilities such as getting out of your home [item D2.4]; walking a long distance [D2.5]; learning how to get to a new place [D1.4] (J.-F. Trani et al., 2011; WHO, 2013).

When developing empirical applications based on the Capability Approach, especially in order to combine specific features from education and transportation studies, the "selection of valuable functionings that fit the purpose of the theory or application" (Robeyns, 2017) seems imperative. A significant contribution is brought by Biggeri and Libanora (2011), who operationalized the Capability Approach together with children aged 11-17 years old. They highlight the potential of the CA for understanding children's well-being and include core concepts of urban mobility in their list of capabilities, *e.g.* mobility and time-autonomy, which are considered important or very important by the majority of children (Biggeri and Libanora, 2011). Regarding specifically the access to school by active modes, where children are exposed and constrained by the public space circumstances, the evaluation of the walking conditions to and from school are largely determined by the capabilities that children tend to value more, for instance education, participation and social relations (Carver et al., 2005; Ulset et al., 2017).

In addition, schools are the unit of analysis when the issue of children walking to and from schools is examined, which entails the issue of collective entities and collective capabilities. Originally, the Capability Approach is applied at the individual level, *i.e.*, it aims to measure "the well-being of the person", considering that the "ownership of commodities is a personal matter" (Sen, 1985, p. 10). In fact, Amartya Sen incipiently recognizes the case of "joint ownership and even of social ownership, (...) [in which] the ownership of commodities is not joint but the *use* is meant to be" (Sen, 1985, p. 10, emphasis in original). That seems to resonate with Ingrid Robeyns (2017), who states the CA "is in most cases used as a normative framework for the evaluation and assessment of individual wellbeing *and that of institutions*" (Robeyns, 2017, p. 26,

emphasis added). By acknowledging that "the idea of a collective capability can be understood and can be justified" (Robeyns, 2017, p. 117), the author indicates possible ways to study the access of children and their caregivers to education at the school level, yet warning about the impossibility of setting individual and collective capabilities as exclusive categories. Built necessarily from the bottom-up, the promotion of capabilities is foremost identified among social innovations at the grassroots, *i.e.*, with the implementation of new combinations of capabilities by individuals who engage in acts of collective agency (Ibrahim, 2017). Under the CA framework, it is acknowledged that "gaining the freedom to do the things that we have reason to value is rarely something we can accomplish as individuals" (Evans, 2002, p. 56), which prompts the central role of collective action in increasing individual agency (Cleaver, 2007).

Accordingly, an emerging literature is seeking to better observe the collective capability building process, such as the link between collective functionings and capabilities in the case of poor communities investigated by Solava Ibrahim (2006), in which collective functionings "enhance individual *and* communal well-beings" through an effective feedback mechanism (Ibrahim, 2006, p. 411, emphasis in original). Moreover, in a study on the formulation of policies for people with disability, Trani et al. (2011) highlight the role of given groups within the community (*e.g.* NGOs, community-based organizations, associations) to outline collective capabilities, as they result from the collective action of such groups (Trani et al., 2011, p. 150). That is in line with the case of children's travel behavior, since the observed capabilities of children and caregivers (at the school level) to overcome difficulties collectively when they walk to schools might qualify in a framework of collective capabilities, for instance in the case of schools that present higher shares of walking trips despite facing poor walking conditions.

2.2. Incorporation of children's views on urban mobility

In most parts of the world, there is an increasing concern among scholars and practitioners to develop transport policies that foster child development. These policies address the direct effects of transport on children's well-being in the physical, social, cognitive, psychological, and economic domains (E. O.D. Waygood et al., 2017), as well as the impacts on future mobile practices of children, including the adoption of sustainable and multimodal transport modes (Murray and Mand, 2013). Nevertheless, most of the previous research tend to disregard the opinions of children (Friman et al., 2020; Noonan et al., 2016; Zwerts et al., 2010), which are seen as "being unable to make (sensible) decisions for themselves" (Mitchell et al., 2007). Especially in local mobility projects, children's views might "offer policy-makers a means to potentially change preferences and travel behaviour in order to promote the use of more sustainable (and independent) transport modes" (Zwerts et al., 2010).

A first body of studies addressing the effects of transport from the point of view of children arose originally in Medicine-related publications, indicating the benefits of walking with being physically active (Carver et al., 2005; Timperio et al., 2004). Such topics were further incorporated by transport-related academic journals, addressing the issue of children's independent mobility (Buliung et al., 2016; Fyhri et al., 2011b; Fyhri and Hjorthol, 2009), active school travel (Fusco et al., 2012; Hinckson, 2016; Pojani and Boussauw, 2014; Romero, 2015), and the aspects of children's communities and daily lives (Babb et al., 2016; Depeau et al., 2017; Waygood and Friman, 2015). These works are largely based on the direct consultation to children and adolescents, whereas a small proportion of them resorts solely to the caregivers' perceptions about the travel experiences of their children (Babey et al., 2009; Ravensbergen et al., 2019) and some of them to the views of both children and their families about their transport habits (Buliung et al., 2016; Crawford et al., 2017; Depeau et al., 2017; Fyhri and Hjorthol, 2009; Hinckson, 2016; Johansson et al., 2010; Villanueva et al., 2012; Zwerts et al., 2010). The children surveyed in such empirical studies covered a wide age range (5 to 18 y/o), with a prevalence of older children and adolescents aged between 9 and 15 years old. The great majority of the data collection approaches are school-based, with a varied sample size (min: 18, max: 3451, median: 143). In addition, most of the studies were implemented in a set of high-income countries (principally Australia, Canada, New Zealand, and the United Kingdom).

The selection of an appropriate research design for listening and analyzing children's voices and opinions is critical when dealing with children, mainly due to the emergent skills of writing and reading, which generally requires the incorporation of oral and visual productions to capture the perceptions of children (Moola et al., 2015). In this sense, the great majority of the

published research adopts mixed methods, with a prominence of GPS tracking, activity-travel diaries, and questionnaires for quantitative-oriented analyses, and focus groups, drawings, and interviews in rather qualitative approaches, as indicated in the references reviewed in Table 6. In addition, only half of them describe methods for analyzing qualitative data in a structured way. While thematic coding is broadly adopted within and about transport-related publications, mainly in the qualitative research carried out in Australia, Canada, and New Zealand (Castonguay and Jutras, 2009; Crawford et al., 2017; Egli et al., 2019; Fusco et al., 2012; Noonan et al., 2016; Ravensbergen et al., 2019; Romero, 2015), other approaches such as ethnography and activity theory are found among European researchers in studies outside the transport field, such as public health, geography, and childhood issues (Den Besten, 2010; Porter et al., 2010; Quarmby and Dagkas, 2013).

In a context in which children are being increasingly deprived from autonomy, agency, and deliberation due to the "prevalent social construction of children as dependent" and the "appearance of good parenting" (Mitchell et al., 2007), it is crucial to revisit previous research designs, which have "been limited to singular qualitative methods that overlook children's varied linguistic ability and interaction preference" (Noonan et al., 2016) and "tended to neglect the emotionality of mobile space" (Murray and Mand, 2013). That seems to be even more relevant when dealing with qualitative research, since these approaches generally cover a more extended age range and "effectively engage children" (Fusco et al., 2012). Once multiple qualitative methods are combined, they might allow children "to document their social worlds and place their views and experiences at the foreground of the research process" (Fusco et al., 2012).

Most of the studies that present structured procedures for analyzing qualitative data combine multiple data collection approaches, including the adoption of activities that are applicable in typical school environments such as drawing, photography, and focus groups,(Crawford et al., 2017; Den Besten, 2010; Fusco et al., 2012; Noonan et al., 2016) and the adaptation of traditional quantitative methods like activity-travel diaries, questionnaires, and GIS surveys (Egli et al., 2019; Quarmby and Dagkas, 2013; Ravensbergen et al., 2019).

To analyze the data, thematic coding is applied throughout the studies that incorporate quantitative methods like questionnaires and GIS surveys, even though it is also adopted by publications whose data stem solely from visual and oral productions, as indicated in Table 6. Some works use semi-structured focus groups to identify broad emerging themes of both children and their parents, whose transcripts are further coded and categorized following predetermined frameworks and models for children's mobility (Crawford et al., 2017; Noonan et

al., 2016), whereas other authors combine questionnaires, drawings, and participatory GIS surveys (PPGIS) to capture child perspectives about their route to school (Egli et al., 2019; Romero, 2015), whose responses are coded into software packages for qualitative data analysis. Other approaches for data collection include: i) photovoice and story-writing discussions about what children perceive as dangerous (Mitchell et al., 2007); ii) audio-narratives of perceived barriers and facilitators to walking (Rodriguez et al., 2019); iii) responses to open questions written by parents within activity-travel diaries (Ravensbergen et al., 2019); and iv) children's visual productions such as drawings, photographs, and videos about their desired walking routes in low-income communities (Moola et al., 2015), which are similarly analyzed using thematic coding. Furthermore, studies involving thematic coding cover a younger age range between 7 and 15 years old, in which visual methods for data collection such as drawing and photovoice are found among children up to 12 years old.

On the other hand, the methods brought by research outside the transportation field generally rely on a single data collection approach and are applied with older children between 10 and 18 years old. These include interviews (mobile and semi-structured), and drawing of subjective maps, which are further analyzed according to field-based techniques such as ethnography, analytical induction, and activity theory.

While acknowledging the effectiveness of the research methods previously implemented to identify relevant problems and important relationships in children's travel, Friman et al. (2020) point out the need for new methods of including children's voices in order to "more explicitly make children's voices heard, and acknowledged, during transport planning processes" (*Ibid.*). Indeed, the analysis of qualitative research with children has been limited to cross-sectional studies and generally consider small sample sizes, as indicated in Table 6, which might hamper the drafting of long-term transport policies focused on childhood development. To that end, the new and interactive technologies in co-design and co-creation activities might help creating solutions to the relevant problems in children's transport for the future (Friman et al., 2020). In this sense, the rise of programming tools to analyze qualitative data such as text mining, sentiment analysis, and natural language processing can assist policymakers in developing a framework for transport planning based on the users' experiences, since they provide "a different approach to data collection and analysis and another perspective towards understanding consumers' emotions" on a very large scale and over a long period of time (Mogaji and Erkan, 2019). Within the transport field, there are seminal applications of algorithms to capture meaningful insights from a large amount of qualitative data, including the identification of enablers and barriers for adopting public bike sharing systems (Serna et al., 2019), the diagnosis of problems and solutions from road safety inspections (Roque et al., 2019),

public opinion about transportation policies (Chakraborty and Sharma, 2019), and the customer experiences in train transportation services (Mogaji and Erkan, 2019).

Table 6: Review of studies covering the topic of children's views about transportation. Papers involving younger children (up to 6 years old), data collection with both children and caregivers, and structured methods for qualitative data analysis are highlighted (in gray). NA: not available; NA*: not school-based. NA**: focus on quantitative data analysis only.

Author-year	Age-range (children)	Consultation to children/careg.	Method of data collection	Sample size (children/schools)	Method of qualitative data analysis
Egli et al. 2019	8 to 13	Y / N	GIS survey; questionnaire	1102 / 19	Thematic coding
Ravensbergen et al. 2019	NA	N / Y	Activity-travel diary	70 / NA*	Thematic coding
Rodriguez et al. 2019	12 to 13	Y / N	Questionnaire	26 / 2	NA**
Crawford et al. 2017	8 to 15	Y / Y	Focus group	132 / 7	Thematic coding
Depeau et al. 2017	10 to 12	Y / Y	Interview; GPS tracking	22 / NA*	NA
Babb et al. 2016	9 to 13	Y / N	GPS tracking; Activity-travel diary; Photo	49 / 1	NA
Buliung et al. 2016	9 to 13	Y / Y	Activity-travel diary	1035 / 17	NA**
Hinckson 2016	8 to 16	Y / Y	Focus group	78 / 10	NA
Loebach & Gilliland 2016	9 to 13	Y / N	GPS tracking	143 / 7	NA**
Noonan et al. 2016	10 to 11	Y / N	Focus group; drawing	35 / 7	Thematic coding
Moola et al. 2015	9 to 13	Y / N	Drawing + Photovoice	46 / 3	NA
Romero 2015	9 to 11	Y / N	Questionnaire; drawing; focus group	178 / 8	Thematic coding
Waygood and Friman	10 to 11	Y / N	Activity-travel diary	411 / 6	NA**
Pojani and Boussauw	11 to 13	Y / N	Questionnaire	472 / 4	NA**
Quarmby and Dagkas	11 to 14	Y / N	Semi-structured interview	24 / NA*	Analytical induction
Fusco et al. 2012	10 to 12	Y / N	Photovoice	41 / 4	Thematic coding
Villanueva et al. 2012	10 to 12	Y / Y	Questionnaire	1480 / NA	NA**
Fyhri et al. 2011	5 to 12	Y / N	Travel survey	NA / NA*	NA**
den Besten 2010	10 to 13	Y / N	Drawing (subjective maps)	233 / 6	Activity theory
Johansson et al. 2010	13 to 14	Y / Y	Questionnaire	1008 / 44	NA**
Page et al. 2010	10 to 11	Y / N	Questionnaire	1307 / 23	NA**
Porter et al. 2010	12 to 18	Y / N	Mobile interview	18 / NA*	Ethnography
Zwerts et al. 2010	10 to 13	Y / Y	Questionnaire	2546 / 76	NA**
Babey et al. 2009	12 to 17	N / Y	Questionnaire	3451 / NA	NA**
Castonguay & Jutras	7 to 12	Y / N	Photovoice	35 / NA*	Thematic coding
Fyhri and Hjorthol 2009	6 to 12	Y / Y	Questionnaire	1774 / NA*	NA**
Mitchell et al. 2007	6 to 11	Y / N	Story-writing+discussion; photovoice	131 / 3	NA

2.3. Travel behavior change through interventions with children

Within the mobility domain, a prominent discussion concerns the broad field of behavioral change, mostly motivated by the recognition of the negative consequences of private car use, such as global warming, congestion, road traffic mortality, and encroachment of land (Gärling and Fujii, 2009; Richter et al., 2010). Furthermore, the shift from long-term infrastructure expansion strategies to shorter-term infrastructure management strategies in the 1970s endowed mobility studies with the need of acknowledging the user responses to short-term transportation policies with a behavioral-oriented approach (Cairns et al., 2008; Richter et al., 2010; Van Acker et al., 2010).

In this sense, a set of transport policy measures emerged with the aim at reducing car use, such as the prohibition, rationing and the increase of costs for car use – known as "hard measures", often politically infeasible and meeting with public disapproval – and the development of strategies to motivate individuals to voluntarily reduce car use – also referred to as "soft measures" or *voluntary change measures* (Gärling and Fujii, 2009). Although the soft change measures occasionally include elements of the "hard" nature in its strategies (*e.g.* workplace travel plans often including parking restrictions), the interventions directed towards voluntary behavioral change usually address psychological motivations for travel choice through the provision of customized information, incentives, and feedback (Richter et al., 2010). These might be adopted to either alter the available travel options (*e.g.* road or congestion pricing that increases monetary costs and decreases congestion) or to change car users (*e.g.* information and education measures) without any changes in travel options. In both cases, the goal is a change in the mobility behavior (Gärling and Fujii, 2009).

Such measures present a variety of positive outcomes, although it is difficult to infer their theoretical and practical implications mainly due to differences in style and completeness of reporting in different contexts and the usual implementation by private consulting companies, which is commonly not accessible to researchers (Richter et al., 2010). Richter et al. (2010) have proposed the categorization of these measures into two main types: marketing management (MM) and travel feedback programs (TFP). The categorization is influenced by the broad scientific experience in Japan in evaluating soft transport policy measures, where researchers are highly involved in the implementation, evaluation and development of such measures (*Ibid.*). The former (MM) refers to the "transportation management policy that adopts soft measures to induce reductions in car use and increases in sustainable transportation modes such as public transport, bicycling, and walking" (Taniguchi and Fujii, 2007a) by using communication and marketing techniques. The TFPs "share the common feature that targeted car users receive feedforward and feedback": feedforward includes travel information (time tables, maps about

alternative travel options); feedback refers to information about behavioral consequences (*e.g.*, CO2 emissions caused by car use) (Fujii et al., 2009). Examples of TFPs include individualized Marketing, Travel Smart, Travel Blending, and the Wise Way to Use a Car Program, and might differ with respect to location, technique, and methodological and operational procedures (Fujii et al., 2009; Taniguchi and Fujii, 2007b).

With the usual duration of four weeks, the evaluation of the measures that seek to promote changes in mobility behavior have identified several effects, including shifts towards walking and/or cycling in trip rates, vehicle kilometers travelled, travel time, and choice of travel mode (Richter et al., 2010). Additionally, they present a common approach of data gathering, namely surveys and questionnaires, though implementing a diverse range of techniques and evaluation methods.

The first empirical studies addressing behavioral changes in children emerged in Medicine-related publications in the 2010s, with the evaluation of established programs to increase children's active commuting to school and decrease traffic congestion, namely the Walking School Bus (Mendoza et al., 2011; Sayers et al., 2012) and school travel plans (Hinckson and Badland, 2011). These topics were further incorporated by transport-related academic journals, which assessed the health benefits of active transport and injury reduction that were brought by cycle training courses (Ducheyne et al., 2014), increased crossing guard presence (Gutierrez et al., 2014), and school-based interventions (Christiansen et al., 2014). These narratives were commonly embedded with the belief that "reducing this dependence [of auto transportation] at an early age may establish a lifelong pattern of active transportation" (Sirard et al., 2015, p. 29).

The evaluation of such interventions covered a broad range of school-based strategies, including obesity prevention programs (Xu et al., 2015), peer-mentoring about physical activity (Tymms et al., 2016), lessons about active transport in a driving license course (Verhoeven et al., 2016), and a variety of initiatives aiming to encourage active commuting with children (*e.g.*, cycle training, school travel plan, Safe Routes to School). Many of them nonetheless reported no significant effect of the implemented measures on increasing physical activity (Harrington et al., 2018; Sayers et al., 2012; Tymms et al., 2016) or promoting walking or cycling to school (McMinn et al., 2012; Østergaard et al., 2015; Teixeira et al., 2019), even when large-scale policy changes were considered (Sirard et al., 2015). The lack of evidence of the interventions' impact is reported predominantly among older children (aged 11 and above), and no difference in effect across gender and socio-economic position has been identified (Love et al., 2019).

However, other studies did identify a positive impact of the interventions among younger children (aged under 10 years old), including the increase in active transport due to school travel plans (Hinckson and Badland, 2011), awareness raising activities (Villa-González et al.,

2016), and the implementation of the Safe Routes to School program (Hoelscher et al., 2016). Similarly, an intensification of physical activity was noted among younger children as a result of other school-based initiatives, namely the Healthy Choices Programme (Shannon et al., 2018) and the Walking School Bus (Mendoza et al., 2011).

Besides the paucity of intervention studies covering younger children and teenagers, another limitation reported in the literature is associated with the substantial heterogeneity and low quality of evidence across studies, underscoring a need for stronger study designs in this area of research (Larouche et al., 2018), which is still in an early stage (Schönbach et al., 2019). The search for robust studies includes the consideration of panel research designs, longer follow-ups, standardized outcome measures, and potential mediators of travel behavior change to help refine current interventions (Larouche et al., 2018).

The papers reviewed for this manuscript were collected through the ISI Web of Knowledge platform (apps.webofknowledge.com) on March 2020 and cover the topics “transport*” or “mobility”, followed by “child*” and one of the following terms: "behavior change", "behaviour change", "treatment group", "control group", or "causality", totaling 10 different combinations. From the 410 publications originally collected, only 18 involved empirical research in children's physical activity or urban mobility with children. From these, 13 works were excluded due to the following exclusion criteria: no pre/post research design (n = 8); no intervention (n = 3); and review article (n = 2). The two review articles obtained then provided 12 other studies involving pre-post research with children and were included in the review process, resulting in 17 papers, as presented in Table 7 (below).

Most published research has been implemented in a set of countries in Western Europe (mainly in the UK, Belgium, and Denmark) and in the USA, with a varied sample size (min: 77, max: 13,631, median: 494) and covering a wide age range (8 to 18 y/o.), with a prevalence of children and adolescents aged between 8 and 14 years old. The majority of the research approaches is school-based, with a widespread adoption of questionnaires for data collection and a set of tools for analyzing data, including regression models and other statistical tests to assess differences in the relevant metrics (*e.g.*, T-test, F-test, Chi-squared test, odds ratio).

Some studies that included control and treatment groups in their research approaches acknowledged difficulties comparing intervention schools with "business as usual" controls (Tymms et al., 2016), especially with regard to the recruitment of public schools (Østergaard et al., 2015). In this sense, other studies made adjustments by either categorizing schools according to their funding allocation in infrastructure (Hoelscher et al., 2016) or combining strategies from a baseline intervention (Verhoeven et al., 2016). These controlled evaluations, however, were not limited to the effect of the proposed interventions on established measures such as the

degree of active commuting to school and the level of children's physical activity, but have also included the change in children's perceptions towards active modes, including the safety perception and motivation to walk (Villa-González et al., 2016), attitude towards bicycling (Christiansen et al., 2014), and psychological needs and autonomy-support from teachers (Shannon et al., 2018). In a recent evaluation of the Walking School Bus program, Nikitas et al. (2019) indicate that exploring perceptions and attitudes of both students and adults (caregivers, teachers, *etc.*) about school travel can be particularly helpful in expanding the understanding behind the uptake of school-based interventions and their long-term viability.

A number of research findings have indeed acknowledged the mutual influence between travel behavior and its psychosocial determinants, particularly the attitude and perceptions towards using different transport modes (Kroesen et al., 2017; Line et al., 2010; Villa-González et al., 2016). These follow the usual assumption that attitudes influence behavior (Janke and Handy, 2019) and resonate with the reported associations of active transport and physical activity with parental perceptions on environmental characteristics (De Meester et al., 2014), as well as positive cycling experience and negative attitudes towards cars (Sigurdardottir et al., 2013). Some of these studies did not detect any intervention effect on active commuting, but on "parental encouragement and student attitude towards bicycling" (Christiansen et al., 2014, p. 175) and on creating "awareness and intentions of change" (Teixeira et al., 2019, p. 20). That way, these studies support the assumption that such psychosocial factors of active transport are "the first step in order to achieve a change in behaviour" (Verhoeven et al., 2016, p. 1).

Despite being primarily implemented with children and school staff, such interventions seem to also influence the behavior of other family members, as does the positive parental attitude towards cycling due to a course to improve children's cycling skills (Ducheyne et al., 2014) and a school-based physical activity program (Christiansen et al., 2014). The influence of children on the transportation needs of their caregivers is similarly found in research covering awareness activities about environmental characteristics (Villa-González et al., 2016), children's independent mobility (Vlaar et al., 2019), and the impact of the children's development on the bicycling attitudes and behavior of caregivers (Janke and Handy, 2019).

In effect, Nikitas et al. (2019, p. 485) acknowledge the role of enhancing children's "perceived safety, health, emotional and environmental value" as a way of optimizing school-based initiatives to change children's travel behavior. Here, the use of active discussion groups with young people has been successful (Shannon et al., 2018), more suitable and less intimidating than quantitative methods (Line et al., 2010). Nevertheless, the adoption of such qualitative research approaches to acknowledge behavioral changes in commonly disregarded groups of children has been limited to a reduced set of transport-related studies, including the situation of low-income populations (Shannon et al., 2018), children with migration background (Schönbach

et al., 2019), and school communities in developing countries (Xu et al., 2015). Furthermore, there are few examples of participatory research methods tailored to children and youth in travel behavior research, even though these approaches have been recognized as drivers of "change in activity levels" throughout childhood (Tymms et al., 2016, p. 5). That echoes a range of theoretical backgrounds demanding "new approaches that are more aware of social inequalities and diversity" and seeking to regard children as "subject of rights, participative, competent and socially active" (Sarmento et al., 2018, p. 152). In this sense, it seems necessary to elaborate research strategies tailored to vulnerable children, particularly in a context of child poverty generated by the economic and financial crisis (Sarmento et al., 2018) and escalating transnational and rural-urban migration in the Global South (Davis, 2006), which might strengthen the quest for effective interventions to promote sustainable mobility.

Table 7: Review of empirical studies covering changes in the travel behavior of children using a pre/post research design (in reverse chronological order). Interventions with an identified positive effect on active commuting or moderate-to-vigorous physical activity are highlighted (in gray). * Consultation to school officials; † Schools as unit of analysis; NA: not available.

Author-year	**Age range (children)**	**Intervention**	**Consultation (child/caregiver)**	**Sample size (children)**
Teixeira et al. 2019	NA	Soft transport policy package	N / Y	NA
Harrington et al. 2018	11 to 14	Programme to increase physical activity	Y / N	1 211
Shannon et al. 2018	8 to 9	Healthy Choices Programme	Y / N	155
Hoelscher et al. 2016	9 to 10	Safe Routes to School	Y / Y	78 †
Verhoeven et al. 2016	17 to 18	Lesson in driving license course	Y / N	441
Villa-Gonzalez et al. 2016	8 to 11	Awareness raising activities	Y / N	494
Tymms et al. 2016	11 to 12	Peer mentoring + participative learning	Y / N	1 494
Ostergaard et al. 2015	10 to 12	Cycling promotion programme	Y / N	2 401
Sirard et al. 2015	10 to 11	School choice policy change	N / N *	40 †
Xu et al. 2015	9 to 10	Obesity prevention program	Y / Y	1 182
Ducheyne et al. 2014	9 to 10	Cycle training course	N / Y	94
Christiansen et al. 2014	11 to 14	Physical activity intervention	Y / N	1 014
Gutierrez et al. 2014	NA	Increased crossing guard presence	Y / Y	NA
Sayers et al. 2012	NA	Walking School Bus	N / Y	77
McMinn et al. 2012	8 to 9	School-based active commuting intervention	Y / N	166
Mendoza et al. 2011	9 to 10	Walking School Bus	Y / Y	149
Hinckson and Badland 2011	NA	School Travel Plan	Y / N	13 631

2.4. Summary of Literature Review

In this section, a set of academic publications has been reviewed to support the assessment of the effects of school-based interventions on changing the travel behavior of children and caregivers. To do this, the literature review was divided in three main areas, namely the intersections of the Capability Approach with childhood issues and travel behavior (section 2.1), the methods to incorporate children's voices and views about urban mobility (section 2.2), and the impacts of school-based interventions on transport-related behavioral changes (section 2.3).

In the section on the Capability Approach, a research gap was found regarding the incorporation of the CA metrics (for instance capabilities and functionings) in transport-related topics through empirical research, which is combined with a potential of capability-based metrics to address socio-spatial inequalities in transportation, especially with regard to the possible avenues for measuring the potential mobility and its intersection with the available resources, rather than being limited to the effective and observed mobility practices that are most commonly found in the literature. The identified research gaps are directly associated to key research question number 1 (K-RQ1): How can we capture and understand the way mobility capabilities enable the different mobility functionings in early childhood? See Table 1, Table 2, and Table 3 for further details on the association of K-RQ1 with the respective specific objectives (S-O1 and S-O2) and specific research questions (S-Q1 to S-Q8) of this doctoral research.

The empirical literature about children's voices in travel behavior research revealed a wide range of strategies seeking to incorporate the perceptions of children in transport planning such as drawings, photography, photovoice, activity-travel diaries, focus groups, questionnaires, and participatory GIS. Nevertheless, Margareta Friman et al. (2020) point out the need for new methods in order to "more explicitly make children's voices heard, and acknowledged, during transport planning processes" (Friman et al., 2020). This is in line with the urge to revisit previous research designs pointed out by some authors, which "tended to neglect the emotionality of mobile space" (Murray and Mand, 2013) and have "been limited to singular qualitative methods that overlook children's varied linguistic ability and interaction preference" (Noonan et al., 2016). In this sense, there seems to be a research gap in developing methods that seek to listen to the opinions of children, especially the younger ones, in a participatory way, especially when considering the present context in which children are being increasingly deprived from autonomy and deliberation due to the "prevalent social construction of children as dependent" and the "appearance of good parenting" (Mitchell et al., 2007). In addition, the use of open source analytical tools to deal with both qualitative and quantitative data in a reproducible way (for instance text mining, sentiment analysis, and natural language

processing) is still poorly adopted in research on children's travel behavior. Once new methods are combined to listen to children and to analyze data, it is believed that they help create solutions to the relevant problems in children's transport for the future. The identified gaps are therefore in line with key research question number 2 (K-RQ2): How can we incorporate the views and perceptions of preliterate younger children into travel behavior research? See Table 1, Table 2, and Table 3 for further details on the association of K-RQ2 with the respective specific objective (S-O3) and specific research questions (S-Q9 and S-Q10).

Similarly, the literature covering the strategies that seek to change the travel behavior of children towards sustainable mobility seems to be in an early stage (Schönbach et al., 2019), thus underscoring a need for stronger study designs in this area of research (Larouche et al., 2018). A number of references found have recognized the influence of perceptions, attitudes, and psychosocial determinants on travel behavior, and covered a wide range of interventions such as school travel plans (Hinckson and Badland, 2011), the Walking School Bus (Mendoza et al., 2011; Sayers et al., 2012), cycle training courses (Ducheyne et al., 2014), and physical activity interventions (Christiansen et al., 2014). However, the issues concerning the child-caregiver relationship and the methods for examining both perceptions and the effective mobility of children remain under-researched, especially in the context of younger children in the Global South. This discussion has a direct relationship with key research question number 3 (K-RQ3): Do specific interventions in schools affect the travel behavior of children and caregivers in the short term? See Table 1, Table 2, and Table 3 for further details on the association of K-RQ3 with the respective specific objectives (S-O4 and S-O5) and specific research questions (S-Q11 to S-Q15).

The disregard of younger children (particularly under 8 years old) is therefore remarkable throughout the literature review, besides the shortage of studies involving children with migration background, low-income populations, and communities in the Global South. In addition, there are few examples of participatory research methods tailored to children in travel behavior research, even though these approaches have been recognized as drivers of "change in activity levels" throughout childhood (Tymms et al., 2016, p. 5). This research gap echoes a range of theoretical backgrounds demanding "new approaches that are more aware of social inequalities and diversity" in childhood studies, which seek to regard children as "subject of rights, participative, competent and socially active" (Sarmento et al., 2018, p. 152). In this sense, it seems necessary to elaborate research strategies tailored to younger children under social vulnerability, which might strengthen the quest for effective interventions to promote sustainable mobility, which is embedded with the focus of this thesis on using mixed-method empirical Action Research in public schools from a Global South country, as presented alongside the overarching objective, in section 1.1.

3. Methodology

The doctoral thesis presented follows a mixed methods approach, which is embedded from its theoretical perspective to the fieldwork research and the empirical results. Relying on the key research questions presented in section 1.1, the main outputs of this research can be identified as follows.

i) the influence of mobility capabilities on the effective mobility, *i.e.*, the mobility functionings (K-RQ1);

ii) suitability of innovative data collection approaches in transport research to capture views and perceptions of younger children about urban mobility (K-RQ2); and

iii) the short-term effects of selected school-based interventions on the travel behavior of children and their caregivers (K-RQ3).

An overview of the adopted methodological steps is presented in section 3.1, including a summary of the research methods and tools through a schematic representation and the association of the methods employed with other sections of this thesis.

The Action Research is presented as the theoretical perspective adopted throughout the empirical research, in section 3.2. Subsequently, in section 3.3 the role of the Capability Approach to examine the socio-spatial inequalities of children in accessing schools is presented, which enabled selecting suitable schools for data collection (*cf.* section 3.4). In the selected schools, two different strategies aiming at changing the travel behavior of children and their caregivers were implemented (3.6), whose data collected (3.5) were assessed using a set of data analysis approaches (3.7).

3.1. Overview of research methods and tools

In this doctoral research, a mixed methods approach is proposed to incorporate i) a quantitative stage encompassing statistical and spatial analysis methods to assess the relationship between the mobility capability indicators and the measures of mobility functionings; ii) the adoption of text mining techniques to capture the views and perceptions of younger children in travel behavior research; and iii) the evaluation of school-based strategies on the travel behavior of children and caregivers through a set of statistical tests. An overview of the proposed methodological steps associated with the research questions (section 1.1) and submitted manuscripts is represented in Figure 1, as follows.

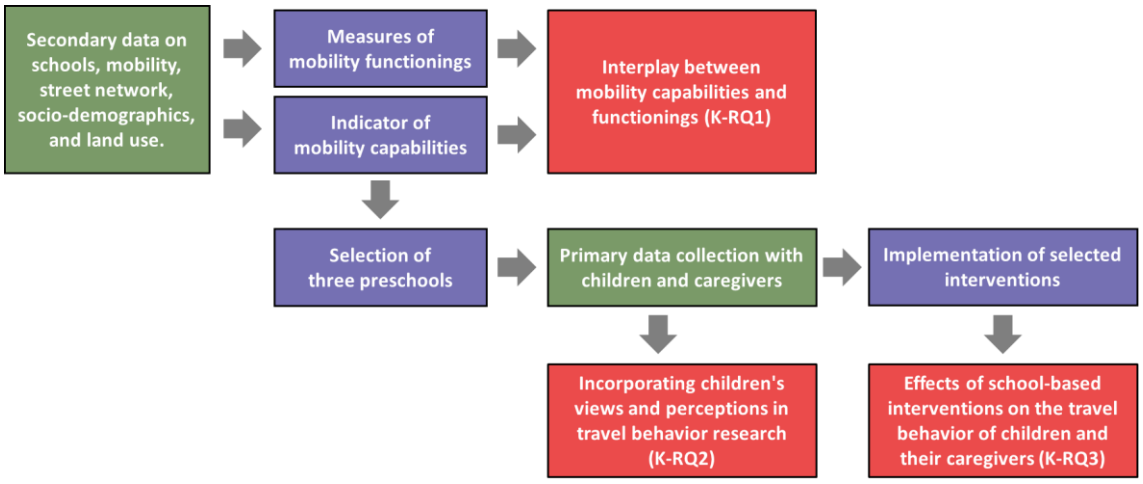

Figure 1: General schematic representation of the proposed methodological steps and associated key research questions (K-RQ).

The proposed methodological approach begins with a quantitative analysis of preschools in São Paulo that involves mainly georeferencing tools and data processing, which is followed by the selection of valuable mobility functionings and the aggregation of mobility capabilities into a composite indicator based on the Capability Approach. This is expected to respond to the first key research question (K-RQ1).

Subsequently, the indicator of mobility capabilities in preschools assisted the selection of suitable public preschools, where data were collected with children and caregivers and the selected strategies to promote changes in travel behavior were implemented. The appropriateness of the proposed method to capture children's views about urban mobility through philosophical inquiry is discussed in more detail in section 5, whereas the effects of the intervention types on the travel behavior of children and their caregivers are addressed in

section 6 . These correspond to the empirical research carried out in this doctoral research and seek to respond to the key research questions number 2 and 3 (K-RQ1 and K-RQ2).

3.2. Action Research as theoretical perspective

This thesis is built around a theoretical perspective entitled *Action Research* (AR), which can be summarized as the "form of action inquiry that employs recognized research techniques to inform the action taken to improve practice" (Lewin, 1946), which is commonly accredited to the early work of psychologist Kurt Lewin (Lippitt et al., 1958). The Action Research provides an established theoretical perspective that meets the combination of both action and thought and the requirements for scrupulous quantitative research (Reason and Bradbury, 2008), including a wide range of application such as technology (Martin, 2008), political change (Hart, 1995), organizational shifts (Freire, 1970), and the implementation of large scale change projects (Greenwood and Levin, 2007; Ross and Bruce, 2012; Tripp, 2005).

The early works covering implementations of the Action Research approach in empirical research conducted with children date from the 1970s, covering a set of issues that are convergent with the research proposed in this thesis, including the impact assessment of interventions to extend the skills of school staff in day nurseries (Laishley and Coleman, 1978), the incorporation of natural expression of children in a study of writing in the kindergarten (Awbrey, 1987), and the development of strategies to increase bicycle helmet wearing (Stevenson and Lennie, 1992).

Besides the "far-reaching benefits" due to the "mutual respect and acceptance fostered in a classroom" brought by the research methods stemming from the Action Research in the school setting (Awbrey, 1987, p. 59), the implications of such research designs can also be identified in transport studies. Porter and Turner (2019) indicate the appropriateness of Action Research in "incorporating and assessing both transport service and infrastructure interventions", particularly in the Global South and rural areas (Porter and Turner, 2019, p. 16). Once associated with mixed method research designs such as "in-depth ethnographic and survey research drawing on a range of disciplinary skills", the assessment of interventions using Action Research "can be particularly powerful in understanding mobility experiences, behaviours and opportunities for positive change" (Porter and Turner, 2019, p. 15). These findings are in line with other publications involving Action Research and mobility-related topics, including the role of AR methods in "eliciting information from street children about their interactions with the socio-spatial environment" with street children in Uganda (Young and Barrett, 2001, p. 141) and

in framing "sustainable transport and social justice on policy agendas" in Chilean cities (Sagaris et al., 2020, p. 1).

Through an Action Research perspective, “communities of inquiry and action evolve and address questions and issues that are significant for those who participate as coresearchers” (Tripp, 2005), where the kind of action inquiry adopted is appropriate to the objectives, interventions, participants, and situation of a research project, including both enablers and constraints. The action inquiry can be defined as a “process that follows a cycle in which one improves practice by systematically oscillating between taking action in the field of practice, and inquiring into it”, which is broadly adopted across disciplines, such as medical treatment, problem solving, and development processes (Tripp, 2005). The characteristics of a research design under the Action Research theoretical perspective differ in some way from traditional scientific research, mainly due to its focus on participatory and interventionist research tools, as indicated in Table 8 below.

Table 8: Characteristics of Action Research and comparison with traditional scientific research and routine practices. Adapted from Tripp (2005).

Routine practice	**Traditional scientific research**	**Action research**
Continuous	Occasional	Continual
Naturalistic	Experimental	Interventionist
Individual	Collaborative / Collegial	Participatory

The continual, interventionist and participatory characteristic of this work derives mostly from the proposed school-based strategies to promote changes in the travel behavior of children and their caregivers. These approaches include the participatory aspect of the weekly open-ended philosophical inquiry sessions held over four months with children, the frequent dialogue between teachers and school staff in the drafting of both classroom-based and outdoor activities, as well as the promotion of active participation of children in the research design through the inquiry sessions and outdoor activities, adaptable to the social context and the surroundings of the schools where most children live (*cf.* section 3.6 fur further details), which differs from the occasional and experimental practices that are commonly found in empirical academic research. The involvement of the school staff in the implementation of the proposed strategies in schools seeks to encourage the continuity of the proposed interventions, besides contributing to the participatory aspect of the proposed research, which was similarly endorsed by the collaboration with a local non-government organization.

The proposed evaluation of interventions on changing the travel behavior of children and their caregivers follows the major influence of projects that stem from the advocacy and the civil society, whose practices are constantly under public questioning and pursuing to demonstrate the measured benefits and impacts of the implemented interventions. Nevertheless, the hasty nature of the organizations and activists commonly prioritizes the adoption of simpler methodological procedures, which is combined with the strong demand for communication with the broad public that is required by most of the donors and sponsors of associations, agencies, foundations, NGOs, *etc*. The incorporation of scientific validation methods is therefore expected to assist the consolidation of the mentioned projects within the field of urban mobility studies and academia.

3.3. Mobility capabilities and functionings from the Capability Approach

In this research project, the concepts of "capability" and "functionings" in mobility studies are explored and developed, as well as its suitability and applicability in quantitative research approaches. Nevertheless, the broad uptake of the term across disciplines requires here a brief statement on the specific understanding of "capability" that is adopted under the presented thesis project.

As indicated by Pereira et al. (2017), the most overlooked question in the transport literature seems to be related to "the moral principles that should guide and justify redistribution" in transport policies (Pereira et al., 2017, p. 178). Most existing literature does not commit to any specific theory of justice and neither "justify why observed inequalities in transport-related benefits and burdens should be considered unfair" (Pereira et al., 2017, p. 178).

While acknowledging that a significant part of the growing literature on transport justice is focused on the "development of new and different methodologies and methods for understanding and addressing justice in transport and mobilities" (Verlinghieri and Schwanen, 2020, p. 2), considerations on normatively oriented multidimensional metrics of transport justice are still scarce. In-depth theoretical considerations about justice and other ethical issues are not addressed in past transport research and have been unjustifiably underdeveloped in contemporary studies (Verlinghieri and Schwanen, 2020, p. 5). Most contemporary literature focusing on the evaluation of transport and mobility justice does not seem to have a "toolkit" of methods and measures to address the complexity of assessing fairness in transport-related issues (*Ibid.*).

As indicated in section 2.1, the potential of Sen's Capability Approach to address different dimensions of transport exclusion and inequalities is recognized, as well as its appropriateness to grasp interpersonal differences in accessibility levels (Pereira et al., 2017). To this end, the "selection of valuable functionings that fit the purpose of the theory or application" (Robeyns, 2017) seems imperative when developing empirical applications based on the Capability Approach.

Alongside the significant contribution brought by Biggeri and Libanora (2011) in the operationalization of the Capability Approach with children, a conceptualization of capabilities and functionings within the transport domain is proposed by Eda Beyazit (2011). Following Beyazit's work and relying on widespread contributions about the CA (Kuklys, 2005; Nussbaum, 2007; Robeyns, 2017), the concept of conversion factor can be outlined in the context of urban mobility and the access to schools, as presented in Table 9. These are expected to guide the application of the Capability Approach in the quantitative assessment of the access to preschools and nurseries by children through walking, which is expected to inform public policies and guide empirical research.

In addition, the aggregation method used to estimate the level of resources (conditions to walk) were based on a set of measures seeking to calculate deprivation scores and the multidimensional impact of children using the Capability Approach, which minimizes the compensation of a metric's low performance by a high score by another metric and differs from the additive compensatory ones that are commonly applied in the development of multicriteria indexes in the transport domain. These concepts and measures are further explored and applied in section *4. Investigating the mobility capabilities and functionings in preschools in São Paulo*.

Table 9: Proposal of CA concepts within the domain of active mobility and the access to schools at the collective level. [a] Based on Alkire (2005), Sen (1999), Nussbaum (2007), and Beyazit (2011). [b] Based on Robeyns (2005).

CA concept	**Description**
Capability	The real freedom of accessing school through walking. In this research project, there is an emphasis on the measurements of the capability of schools at the collective level, *i.e.*, the opportunity of the schools to be accessed through walking by children and their caregivers given the conditions to walk (resources) and the conversion factors according to the school type (public/private) [a]
Functioning	Actual degree to which schools are successfully accessed through walking by children and their caregivers [a]
Conversion factor	Social and environmental characteristics that influence the relationship between the resources (conditions to walk) and the functionings at the collective (school) level [b]

3.4. Selection of schools

The transport metrics developed from the Capability Approach supported the search for public schools in São Paulo (Brazil) with similar levels of mobility resources according to the Capability Approach, indicating therefore comparable "conditions to walk provided for the children and their caregivers" (Humberto et al., 2020b). In this sense, the following conditions were established in order to obtain a subset of public schools for a comparative study (see Table 10).

Table 10: Selected variables and established thresholds for selecting a subset of public schools with similar levels of conditions to walk (resources). * indicates the variables whose estimates are related to the surroundings of schools (2km service area).

Variable	Threshold
Average home-school walking time	≤ 30 minutes
Average street network circuity *	≤ 1,06
Share of households with public lighting *	≥ 80%
Share of households with open sewage *	≤ 5%
Fatal road crashes among 4 to 6-y/d. Children (2009-2016) *	= 0

Once a reduced set of candidate schools was screened, four schools were selected with respect to the degrees of mobility functionings (share of walking trips to/from school) and to the proximity between schools, in order to facilitate the monitoring of the proposed activities in schools throughout the project, as indicated in Table 11.

Table 11: Conditions to walk and mobility functionings of selected schools and subset of schools with similar levels of resources (conditions to walk). * indicates the variables whose estimates are related to the surroundings of schools (2km service area).

Variable	School 1	School 2	School 3	School 4	Average subset (N=51)
% walking trips (2007)	100%	86%	13%	13%	67%
% PT trips (2007)	0%	6%	87%	72%	27%
% IMT trips (2007)	0%	8%	1%	15%	5%
Average walking time, in min. (2007)	19.8	12.5	12.3	15.0	14.7
Average street network circuity	1.030	1.027	1.020	1.032	1.032
% population aged 0-6 y/o. *	8%	7%	8%	7%	8%
% white population *	73%	63%	74%	78%	67%
% population under social vuln. *	0.0%	2.5%	5.3%	1.4%	8.0%
Average monthly per capita income *	1 172	1 003	1 059	1 829	1 397

The four selected schools present therefore quite similar levels of conditions to walk (resources) and no reported fatal crashes involving children in the surroundings of schools in the last ten years. However, the schools vary significantly with regard to the mobility functionings: in schools 1 and 2, almost all children walked to school in 2007, whereas in schools 3 and 4 the available data indicate that the vast majority of children did not walk to these schools, but instead used public transport. This does not seem to be followed, however, by the available resources in the schools' surroundings, which present similar orders of magnitude. In this sense, the four schools selected sought to provide different levels of mobility functionings (share of pedestrian trips) in schools with similar levels of conditions to walk (resources), which could provide insights into the decisive reasons for which similar conditions to walk might prompt different travel behaviors of children in relation to urban mobility. However, at the beginning of the data collection, school 4 had to be excluded from the research due to the effects of a municipal strike associated with a major change in the school board, including the relocation of the school principal and the pedagogical coordinator. In this sense, after arranging with the school staff and teachers, it was agreed that nine classes would be monitored throughout the project, including two classes in school 1, three classes in school 2 and four classes in school 3. This represented 69, 110 and 138 children in schools 1, 2 and 3, respectively (317 in total) totaling 317 children, which however varied over the school semester.

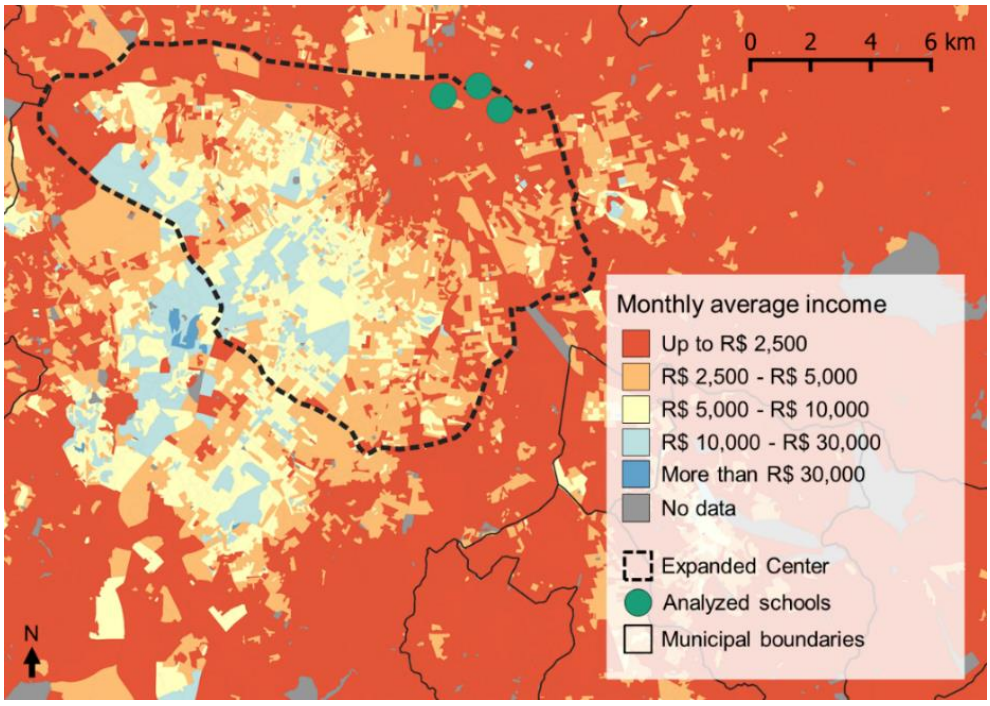

Figure 2: Location of selected schools within São Paulo's "Expanded Center" and per capita monthly average income. Adapted from CEM (2011).

Despite being located within a region known as the "Expanded Center" (*Centro Expandido*) in the city of São Paulo (Brazil) that concentrates most of the jobs and public facilities in the municipality (health, education, transport, culture, etc.), the surroundings of the three selected schools are characterized by poor housing conditions and the concentration of low-income immigrants working in the clothing and textile sector, predominantly from Bolivia (Pucci, 2013). The location of the selected schools within São Paulo's "Expanded Center" as compared with the levels of per capita income can be found in Figure 2 (above).

3.5. Data collection

In this section, the approaches for collecting data are introduced, including the methods to capture the perceptions of younger children about urban mobility and to consult caregivers. These are followed by the presentation of the existing datasets that were helpful to analyze the collected data.

The datasets collected can be classified in primary and secondary data, similar to previous research in urban studies (Franco et al., 2017; Otiso, 2003). Whereas primary data can be understood as the data collected directly from main sources and designed for understanding the research questions of a specific research project, secondary data typically regards existing data collected by someone else earlier, which can include information from the national census, Origin-Destination surveys and other government agencies.

In this doctoral thesis, the primary data collected concern the transcripts of the inquiry sessions based on the Philosophy with Children inquiry approach and the information collected with the children's caregivers through questionnaires. On the other hand, the secondary data used in this research relate to data previously collected by several institutions, including: i) the location of schools (school staff of participating schools); ii) road crashes (Municipality of São Paulo); iii) origin and destination of trips (METRÔ-SP, 2018, 2008); iv) the conditions of the built environment (2010 National census*, cf.* IBGE, 2011); v) the social vulnerability and housing conditions (HabitaSampa, 2019; SEADE, 2012); and vi) the nationality of children and their caregivers (school staff of participating schools). Finally, the ethical considerations regarding data collection and analysis are addressed.

3.5.1. Philosophy with children inquiry approach and questionnaires to caregivers

This section entails the two approaches developed for collecting the data from children and their caregivers that were specifically designed for understanding the research questions of the doctoral research carried out (primary data): the Philosophy with Children inquiry approach and questionnaires to caregivers.

3.5.1.1. Philosophy with Children inquiry approach (data collection)

The search for appropriate methods to inquire younger children (aged 5-6 y.o) about their perception on urban mobility was built around the concepts of the Philosophy with Children (PwC) inquiry approach, which "thinks of philosophy not as knowledge or content but as a relationship with knowledge and thought" (Kohan, 2015). The PwC approach focuses on "creating the conditions to philosophize", which means that everyone sits in a circle, asks for the floor to speak and promotes the relationship between the participants of the inquiry sessions (*Ibid.*). A typical application of PwC involving younger children up to seven years old incorporates the *community ball* to give the "opportunity to call and be called upon by their peers" and sitting in a circle, which "nurtures collaboration amongst the children, helping them to be more focused on the topic", creating a safe place for philosophical inquiry (Jackson and Oho, 1993).

The PwC sessions used in this empirical study were primarily built from a pilot implementation of the PwC methodology involving urban mobility in a nursery school in Lisbon (Portugal) in July 2017, which included the discussion of "themes related to mobility and permanence in the public space, such as going from home to school, playing in the garden and going out to open spaces" (Barreiros et al., 2019a, pp. 183–184). In these practices, the experience of thinking and active participation were encouraged, thus emphasizing the following aspects of the philosophical experience: i) creation of a welcoming environment that fosters the confidence of participants and the willingness to be part of the experience; ii) integration of the affective and intellectual dimension of participants; and iii) a philosophical posture that induces more questioning than certainty (Olarieta and Kohan, 2014, p. 22). These aspects had a major influence on the development of the experiences of philosophical dialogue with children regarding the perceptions of space and movement, in which open discussions with children were sought, "triggered from a question or intentionality that pursued issues related to

space and territory" (Barreiros et al., 2019a, p. 184). A representation of these pilot sessions can be found in Figure 3.

In this doctoral research, a set of 11 different PwC sessions was built by a group of four researchers together with children and staff from the participating schools, which involves aspects of urban mobility from the point of view of children, as indicated in Table 12. A representation of these sessions can be found in Figure 4 and Figure 5.

Table 12: List of proposed PwC sessions to capture the perception of children about urban mobility. * indicates the sessions whose transcripts are considered in this thesis.

#	PwC session	Theme
1	Community ball, making a circle, calling on one another	Preliminary steps in PwC, organizational aspects
2*	Reading and discussion of Marianne Dubuc's book "The Bus Ride"	General perceptions about transportation
3*	"Which places do we go through?"	Daily mobility and places
4*	"What scares you? What encourages you?"	Fear and confidence in children's mobility
5	Listening and discussion of Projeto Sonora's sound installation "Way to school" [1]	Way to/from school (walking, school bus)
6*	Reading and discussion of Anthony Browne's book "Into the Forest"	Fears and threats in children's walking
7*	"What can/cannot be done on the street?"	Concerns and permission by parents/caregivers
8	Review of activities and free drawing	Graphical representation of inquiry sessions
9*	"Where do we play?"	Places and experiences of play/joy
10*	Presentation of Genifer Gerhardt's video "Walking with Tim Tim"[2] and discussion about "What draws our attention when we walk?"	Relevant aspects of walking on the street
11	Closing PwC session and collective drawing	Project finalization and concluding steps

[1] Available at https://www.projetosonora.com/
[2] Available at https://www.youtube.com/watch?v=1dYukOrq5RI

Figure 3: Pilot project "Displacements and Philosophy: perceptions of children about the city" in Lisbon (Portugal), July 2017. *Cf.* Barreiros et al., (2019).

Figure 4: Implementation of inquiry session no. 1 (Community ball, making a circle, calling on one another) in a classroom of school no. 1, April 2019 (Rodrigues, 2019).

Figure 5: Implementation of inquiry session no. 8 (Review of activities and free drawing) in a classroom of school no. 1, May 2019 (Rodrigues, 2019).

During the empirical research in schools (March-August 2019), the project was named "Study on the influence of the built environment on children's mobility in São Paulo" in official documents and *pytá* ("stay" in the Tupinambá Tupian language) in short for children and schoolteachers. Further details about the implementation of the Philosophy with Children inquiry approach in this work are covered in section *5. Incorporating children's views and perceptions in travel behavior research through the Philosophy with Children inquiry approach.*

3.5.1.2. Questionnaires to caregivers

Caregivers were asked to complete a questionnaires in three stages: i) two weeks before the beginning of the PwC sessions (T1: pre); ii) at the end of the proposed interventions in schools (T2: post, four months after T1); and iii) after winter school break (T3: follow-up, six months after T1), covering a set of socio-demographic variables, the adopted transport modes by children and caregivers, and descriptive and injunctive social norms towards active mobility as informed by the caregivers.

The questionnaires were filled out by parents during the project presentation sessions throughout the school semester (65% of the questionnaires delivered) and were sent home to parents who were unable to attend these meetings (35% of the questionnaires delivered). In these presentation sessions (see Figure 6) no reference was made to a specific transport mode,

even though a minor proportion of the caregivers in the initial phase of the project tended to associate the study with the lack of free school buses offered by the municipal government.

Figure 6: Project presentation session with caregivers in school no. 3, June 2019 (EMEI Prof. Pedro Alvares Cabral Moraes, 2019).

A detailed description of the variables collected in the questionnaire to caregivers is provided in Table 13. Further details about the questionnaires are available in *Appendix B: Questionnaires to Caregivers* (in Portuguese and Spanish). The descriptive statistics of the primary data collected (including the questionnaire to caregivers) can be found in Table 23 (section 6.3).

Table 13: Type and description of variables collected (questionnaire to caregivers).

Variable	Description	Type	Stage of study
Transport mode (caregiver)	Which transport mode(s) do you (caregiver) commonly use during the week? 1) Walking; 2) Car; 3) City bus; 4) Bicycle; 5) Subway; 6) Suburban train; 7) Motorcycle; 8) Other.	Nominal. Multiple response question. 8 options available	T1, T2, T3
Transport mode (child)	Which transport mode(s) does your child commonly use to go to school? 1) Walking; 2) Public school bus; 3) Private school bus; 4) Car; 5) City bus; 6) Bicycle; 7) Subway; 8) Suburban train; 9) Motorcycle; 10) Other.	Nominal. Multiple response question. 10 options available	T1, T2, T3
Transport mode of child (escort)	Who does your child usually go to school with? 1) Alone; 2) Father/stepfather; 3) Mother/stepmother; 4) Grandmother/grandfather; 5) Neighbor; 6) Aunt/uncle; 7) Sister/brother; 8) Guardian; 9) Other	Nominal. Multiple response question. 9 options available	T1
Injunctive social norms	In your opinion, other caregivers consider walking to school to be: 1) Very good; 2) Good; 3) Neither good nor bad: 4) Bad; 5) Very bad	Ordinal. Integer values between 1 and 5	T1, T2, T3
Descriptive social norms	In your opinion, children generally walk to school: 1) Never; 2) A few times; 3) Many times; 4) Always.	Ordinal. Integer values between 1 and 4	T1, T2, T3
Age of caregiver	What's your age (caregiver)?	Integer	T1
Gender of caregiver	What's your gender? 1) Woman; 2) Man; 3) Other (specify)	Nominal. Single response question. 3 options available	T1
Household size	How many people live in your house?	Integer	T1
Location of residence	Home address	Text	T1

3.5.2. Complementary data

The complementary data used in this research relate to datasets that were previously collected by several institutions (secondary data), including: the location of schools, road crashes, Origin-Destination surveys, conditions of the built environment, housing conditions, levels of social vulnerability, and the nationality of children and caregivers in the analyzed schools.

Location of schools

To develop the transport metrics from the Capability Approach, an open-access dataset from the *Geosampa* platform was used, containing the georeferenced location of preschools and nurseries in the municipality of São Paulo (N = 4,570) and the information about their school type (public/private) (GeoSampa, 2018a). The dataset underlay the generation of service areas around schools, which enabled the association with other datasets, which are covered in the following sections. Further details about the utilization of this dataset can be found in section *4. Investigating the mobility capabilities and functionings in preschools in São Paulo*.

Road crashes

This dataset stems from the inventory of road crashes collected by the Municipality of São Paulo from 2009 to 2017 (N = 187,451, private database). To identify the ones that are relevant to indicate the degrees of road safety around preschools and nurseries, only the pedestrian-car crashes during school drop-off and pick-up (weekdays at either 6:45am-7:15am, 4:45pm-5:15pm or 6:45pm-7:15pm) were filtered out, resulting in 12,885 cases. These were then intersected with the school surroundings (service areas of 2,000m) for the estimation of road safety in the school surroundings. Further details about the utilization of this dataset can be found in section *4. Investigating the mobility capabilities and functionings in preschools in São Paulo*.

Origin-Destination survey

The mobility data was collected from the 2007 disaggregated dataset of the decennial Metropolitan Origin-Destination survey performed by METRO-SP (N = 196,698 trips). To develop the transport metrics from the Capability Approach for the analyzed schools (*cf.* section 3.1), the education-related trips made by children aged up to 6 years old and enrolled in a preschool were filtered out. Further details about the incorporation of the Origin-Destination

survey data in this work are covered in section *4. Investigating the mobility capabilities and functionings in preschools in São Paulo*.

Built environment conditions

The conditions of the built environment were collected from the decennial national census promoted by the Brazilian Institute of Geography and Statistics (IBGE), whose latest dataset (2010) was processed to collect a set of variables regarding the surroundings of the analyzed schools (IBGE, 2011). Further details about the incorporation of the built environment conditions to estimate relevant metrics for the analyzed schools can be found in section *4. Investigating the mobility capabilities and functionings in preschools in São Paulo*.

Social vulnerability and housing conditions

From the location of households as provided by the caregivers in the questionnaires, it was possible to locate children's households through georeferencing, which enabled the association with public datasets about the housing conditions and the determination of social vulnerability levels. The metric of social vulnerability here adopted is the one calculated by the SEADE state agency to classify the territories in the State of São Paulo in six levels, which were summarized in three groups in this thesis: i) low (extremely low and very low social vulnerability); ii) average (low and average); and iii) high (high and very high). These are calculated using data from the national census such as literacy, employment, and the presence of younger children aged 0-5 y/o (Schumann and Moura, 2015; SEADE, 2012). The housing conditions were obtained from the *Geosampa* platform, managed by the City of São Paulo, which indicates areas with prevalence of squatter settlements and slum areas (HabitaSampa, 2019). Further details about the incorporation of the levels of social vulnerability and housing conditions in this thesis can be found in sections 4, 5, and 6.

Nationality of children and caregivers

In order to supplement the data provided by caregivers (questionnaires) and children (transcripts of inquiry sessions), information about the nationality of children and their caregivers was obtained using school documents as provided by school staff. The nationality of the children and caregivers surveyed originally contains ten different nationalities, but for the sake of simplicity only native and non-native children/caregivers are considered throughout the doctoral thesis. The utilization of this data can be identified in the chapters related to the empirical work, namely sections 5 and 6.

3.5.3. Ethical approval

The proposed approaches for collecting primary data (Philosophy with Children inquiry approach and questionnaires to caregivers) pose minimal risks to participating children and caregivers, due to the minor possibility of embarrassment, discomfort and fatigue while answering the questionnaires (for caregivers) and participating in the open-ended inquiry sessions together with the class teachers (for children). The activities proposed with children follow pedagogical practices in which both consent and participation of children constitute a fundamental element.

To safeguard the identity of the participants, questionnaires to caregivers were marked with a code, one for each caregiver. Prior to the start of the primary data collection, the teachers of the participating classes were requested to make a list attributing a code to each child. The corresponding caregivers were then given the questionnaire with the corresponding code. Once the caregivers have completed the questionnaires, these was handed over to the school office and returned directly to the principal researcher. In this way, it was ensured that the identity of the participants was kept anonymous, as well as their responses to the questionnaires. The researcher does not have access to the information that allows any form of identification and the schoolteachers do not have contact with the questionnaires to caregivers. Similarly, the record sheets containing the transcripts of the inquiry sessions had codes to ensure that the children's identities and statements remained anonymous.

Furthermore, in order to locate the residence and work of the participants through the questionnaire and thereby estimate the distances between home, school and workplaces, the postal codes were requested instead of the complete addresses. This also contributed to the anonymization of the survey participants, since the postal codes provide an estimate of a person's home and work location and makes it impractical to know the exact address of any participant of the empirical research (*e.g.* residence, floor or apartment number).

The preliminary results were disseminated at the end of the project in explanatory sessions held in each of the nine classes in the selected schools for both teachers and caregivers of children participating in the project. For the children, closing sessions of the inquiry sessions were organized in the form of a celebration, informing that this phase of the project had come to an end. Finally, the final results are sent to the principals, teachers and caregivers once the research is published in journals, congresses and other scientific dissemination channels and events.

The data collection and processing methods were approved prior to the data collection and implementation of proposed interventions in schools by the Research Ethics Committee of the Institute of Psychology at the University of São Paulo (CEPH-IPUSP) on December 2018 (No. 3.092.675, CAAE: 03318918.0.0000.5561). Subsequently, the City of São Paulo's Department of Education approved the research project, which was endorsed by the principals from the selected schools. Further details about the ethical procedures, allowances, and protocols can be found in *Appendix C: Approval by Research Ethics Committee and Department of Education* (in Portuguese).

3.6. Strategies to promote changes in travel behavior

In the present research, a program aiming at changing the travel behavior of young children and their caregivers was developed around two strategies (also referred to as intervention types throughout the thesis): i) weekly inquiry sessions about urban mobility through the Philosophy with Children approach and ii) bimonthly outdoor walking activities in the surroundings of schools. They are represented schematically in Figure 7 below, alongside the approaches for primary data collection presented in section 3.5.1 above.

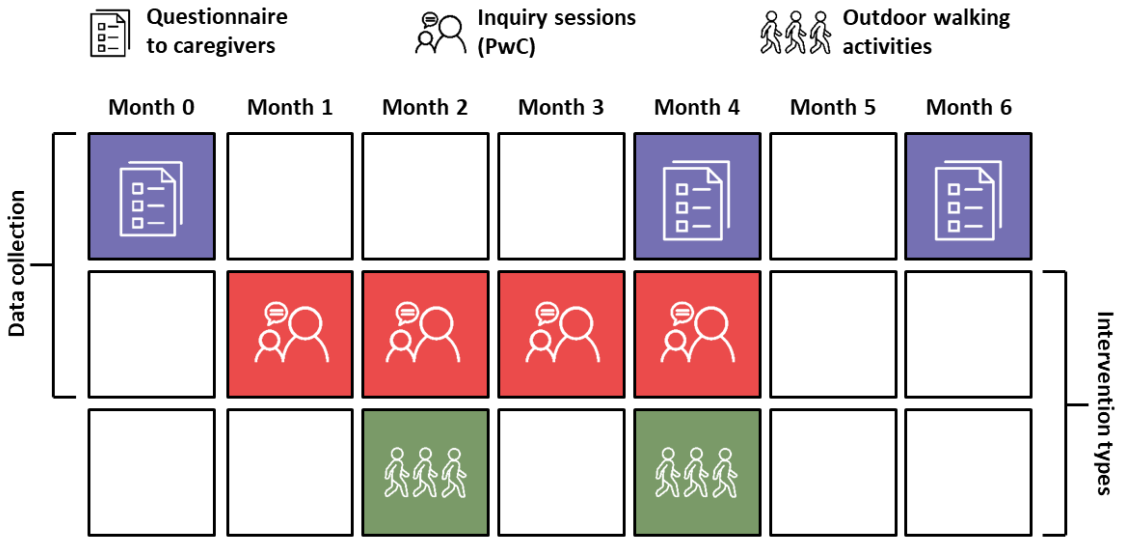

Figure 7: Schematic representation of the adopted data collection approaches and proposed intervention types.

3.6.1. Philosophy with Children inquiry approach (intervention type)

As explored in section 3.5.1.1, the inquiry sessions are built on the concepts of the Philosophy with Children (PwC) approach, which "thinks of philosophy not as knowledge or content but as a relationship with knowledge and thought" (Kohan, 2015). According to Gomes (2019), the "experiences of thinking" proposed by the PwC practices promote the "possibility to *change*" by affirming students' and teachers' different voices and following some methodological steps, including the gathering of collective inquiries and the identification of relevant themes and questions for further discussion (*Ibid.*, emphasis added). In this sense, the inquiry sessions are believed to be both a data collection approach and an intervention type aimed at changing the children's perceptions about urban mobility, as indicated in Figure 7.

In the empirical research conducted, a series of eleven PwC sessions was carried out to address different dimensions of urban mobility from the children's point of view, whose detailed description is provided in section *5. Incorporating children's views and perceptions in travel behavior research through the Philosophy with Children inquiry approach*. Complimentary to the figures presented in section 3.5.1, a representation of these sessions can be found in Figure 8, Figure 9 and Figure 10.

Figure 8: Implementation of inquiry session no. 4 ("What scares you? What encourages you?") in a classroom of school no. 3, April 2019 (EMEI Prof. Pedro Alvares Cabral Moraes, 2019).

Figure 9: Implementation of inquiry session no. 4 (“What scares you? What encourages you?”) in a classroom of school no. 1, May 2019 (Rodrigues, 2019).

Figure 10: Implementation of inquiry session no. 5 (sound installation “Way to school”) in a classroom of school no. 1, April 2019 (Rodrigues, 2019).

3.6.2. Outdoor walking activities

Applied in parallel with the inquiry sessions (PwC), the outdoor walking activities stem largely from a joint research project between the University of Lisbon, the University of São Paulo, and the non-government organization *apē estudos em mobilidade* (apemobilidade.org), which sought to assess the impact of practicing active mobility in the the surrounding of schools on the travel behavior of young children and their caregivers. To achieve this, a series of educational activities through walking in the schools' surroundings (outdoor) was implemented together with the weekly inquiry sessions about urban mobility (indoor), with the participation of children and staff from the participating schools.

The outdoor activities consisted of walks either to a relevant destination located around the schools (e.g. library, museum, public garden, carpet factory) or in the neighborhood itself, which were proposed in collaboration with the local NGO, whose projects seek to "arouse a permanent curiosity in young people" as an "experience of education in urban mobility" (Nogueira, 2015). A representation of these activities can be found in Figure 11, Figure 12 and Figure 13. Further details about these interventions can be found in section *6. Effects of school-based interventions on the travel behavior of children and caregivers*.

Figure 11: Outdoor activities with children from public preschools in São Paulo, “Exploradores da Rua” project, November 2015. *Cf.* Nogueira (2015).

Figure 12: Implementation of outdoor walking activity in the surroundings of school no. 1, June 2019 (Rodrigues, 2019).

Figure 13: Implementation of outdoor walking activity in the surroundings of school no. 2, June 2019 (personal archive).

3.7. Empirical data analysis approaches

A set of analysis tools was proposed once the strategies to promote travel behavior changes were implemented and the data was collected. *Topic modelling and sentiment analysis* were applied primarily in order to evaluate the suitability of the inquiry approach adopted in capturing the views and perceptions of young children about urban mobility. On the other hand, *Time-series analysis and Difference-in-differences* are implemented to assess the impact of the proposed strategies on the travel behavior of young children and their caregivers.

The methods for processing the collected data are largely based on a set of statistical and data science tools developed within R (version 3.6.1), an environment for statistical computing and graphics (Wickham and Grolemund, 2017). In addition to the R functions and packages mentioned in sections 3.7.1 and 3.7.2, most of the procedures for processing and visualizing data are based on a set of functions from the *tidyverse* R package.

3.7.1. Topic modelling and sentiment analysis

To handle the data collected in the inquiry sessions with children, two different approaches for analyzing qualitative data were implemented: topic modelling and sentiment analysis. While both methods stem from linguistics and computational sciences, topic modelling (also known as Latent Dirichlet Allocation or LDA models) are probabilistic models for extracting semantic information from collections of text documents, in which the topic model "learns a set of thematic topics from words that tend to occur together in documents" (Newman et al., 2010). On the other hand, sentiment analysis (also known as opinion mining) seeks to determine the polarity of pieces of text by classifying terms generally as positive or negative, based on predetermined sentiment lexicons (Cambria et al., 2013).

In this work, the underlying topics of the PwC sessions are identified using LDA models from a set of functions within R. First, each segment of text is split in their component words (also known as terms or tokens, using the *tidytext::unnest_tokens* function), the stop words are removed (*tm:stopwords*), then casted into one-token-per-row table called Document Term Matrix (also known as DTM, *tidytext::cast_tdm*), representing the word frequencies during the PwC sessions. Subsequently, a set of LDA models is tested (*topicmodels*::*LDA*, *method = "Gibbs"*) using a number of topics (K) between two and ten.

To determine the polarity of the children's statements using sentiment analysis, two lexicon-based methods are used: i) the AFINN lexicon, composed by 2,477 terms scored in integer values

between -5 and -1 for negative words and between 1 and 5 for positive words (Nielsen, 2015); ii)) the Bing lexicon, which uses a binary classification of 6,786 terms in either negative or positive terms (Bing, 2015). Both lexicons are largely composed by negative terms (65% AFINN, 70% Bing). To calculate the polarity of the children's statements, the segments of text are associated to the AFINN and Bing lexicons (*tidytext::get_sentiments*) once the segments are tokenized and the stop words are filtered out.

Further details about the implementation of topic modelling and sentiment analysis in this research project can be found in section *5. Incorporating children's views and perceptions in travel behavior research through the Philosophy with Children inquiry approach*.

3.7.2. Time-series analysis and Difference-in-differences

To analyze the data collected, two analytical approaches were implemented: time-series analysis and difference-in-differences. While both methods stem from quantitative methods commonly used in economic and health assessments for the estimation of policy effects, a difference-in-differences analysis "compares the change in outcome for an exposed group between a moment before and a moment after the implementation of a policy to the change in outcome over the same time period for a non-exposed group" (Hu et al., 2017). Similarly, a time-series analysis (also known as interrupted time-series) compare the outcomes before and after policy implementation and differs from a difference-in-differences analysis by not requiring a separate control group (*Ibid.*). The time-series analyses undertaken in this doctoral work, while finding resonance in the academic literature, should be understood as repeated measurements within the scope of pre-post assessments, since homonymous analyses may suggest another interpretation in econometric models of similar scientific fields. These approaches together may enable analyzing the variables collected in the inquiry sessions with children (for instance the children's statements about transport modes) and in the questionnaires delivered by caregivers (*e.g.* adoption of active transport, age of caregiver, and home-school distance) not only in a combined way, but also over time and between relevant groups.

In this study, the time-series analysis accounts for the differences in the observed variables between the stages of the study (pre, post, and follow-up, i.e., T1, T2, and T3), whereas the difference-in-differences analysis regards the differences in the consecutive observations (T1, T2, and T3) between the group of children exposed either to the baseline intervention (inquiry sessions, I1) or a combination of interventions (inquiry sessions + outdoor walking activities, I2). Further details about the implementation of Time-series analysis and Difference-in-

differences in this research project can be found in section *6. Effects of school-based interventions on the travel behavior of children and caregivers*.

4. Investigating the mobility capabilities and functionings in preschools in São Paulo

This section seeks to examine and conceptualize the vectors of capabilities and functionings of preschools and nurseries in the city of São Paulo (Brazil), focusing on walking mobility and the differences between public and private schools. These relate mostly to the issues of access of young children (aged 0-6) and their caregivers to the city when walking to and from schools, in which the Capability Approach (CA) is expected to support planning concepts and applications in the context of sustainable transportation to school.

Earlier versions of the work presented in this chapter have appeared in the following conference, webinar and publications:

- Revista dos Transportes Públicos, Volume 41. July 2018 (Humberto et al., 2018a);

- 2018 HDCA Annual Conference. Buenos Aires (Argentina). August 2018 (Humberto et al., 2018b);

- Thematic Group Graduate Student Network for HDCA. Webinar "Work in progress on developing measures using the CA". December 2018;

- Journal of Human Development and Capabilities, Volume 21. March 2020 (Humberto et al., 2020b)

This section is associated to key research question number 1 (K-RQ1) and its specific objectives (S-O1 and S-O2) and specific research questions (S-Q1 to S-Q8). See Table 1, Table 2, and Table 3 (section *1.1. Objectives and research questions*) for further details on the association of key research questions (K-RQ) with the specific objectives (S-O) and specific research questions (S-RQ) of this doctoral research.

4.1. Highlights

- Conceptualization of core CA concepts within the mobility domain: resources, capabilities, functionings and gap between functionings and capabilities;

- Appropriateness of the CA-based metrics to address socio-spatial inequalities in transportation involving children;

- Corroboration of results class and race disparities in the access to education in Brazil;

- Schools with poorer conditions to walk do not have any other options than walking to go to school (e.g. transit or bicycle);

- Schools in wealthier regions present barriers to the fulfilment of active mobility even when the resources are considered sufficient, in which the implementation of educational programs is recommended.

4.2. Data

This study relies on the open-access dataset containing preschools and nurseries in the municipality of São Paulo (N = 4,570), which provides information about their school type (public/private) and location. The dataset underlay the generation of service areas of 2,000 m around schools (i.e. considering the distance along the street network), which correspond to a 30-minute walking distance for a preschool-age child (David and Sullivan, 2005) and is commonly adopted in Brazil as the threshold distance beyond which the school bus services are provided by the public sector (SME, 2018). From the location of schools, available information from georeferenced datasets was incorporated relating to the road safety and the quality of the built environment in the surroundings of schools (for the same service area of 2,000m), which represent the conditions to walk, and the mobility functionings (share of pedestrian trips to school).

4.2.1. Mobility

The mobility data was collected from the 2007 disaggregated dataset of the decennial Metropolitan Origin-Destination survey performed by METRO-SP (N = 196,698 trips). To filter out the children's trips to preschools and nurseries, the following criteria were adopted: i) trips from children aged up to 6; ii) enrolled in a preschool or nursery in the municipality of São Paulo; and iii) whose purpose either in origin or destination is education. A reduced sample of 3,740 trips was obtained, for which expansion factors (m = 207.9 ± 58.1 CI95%) were associated. Coordinates of the schools were provided for each trip, based on the open-access dataset. To do this, 970 school coordinates were assigned to 509 different schools, from an original set of 1,517 coordinates provided by the Origin-Destination survey. Such exclusions are based on: i) the location of the coordinates of the trips within a 1,000m radius from the location of schools, and ii) the minimum of 100 trips to consider the school for further analyses. That resulted in a sample of 204 schools, of which 110 are public. The geographical spread of the analyzed schools in the municipality of São Paulo can be found in Figure 14.

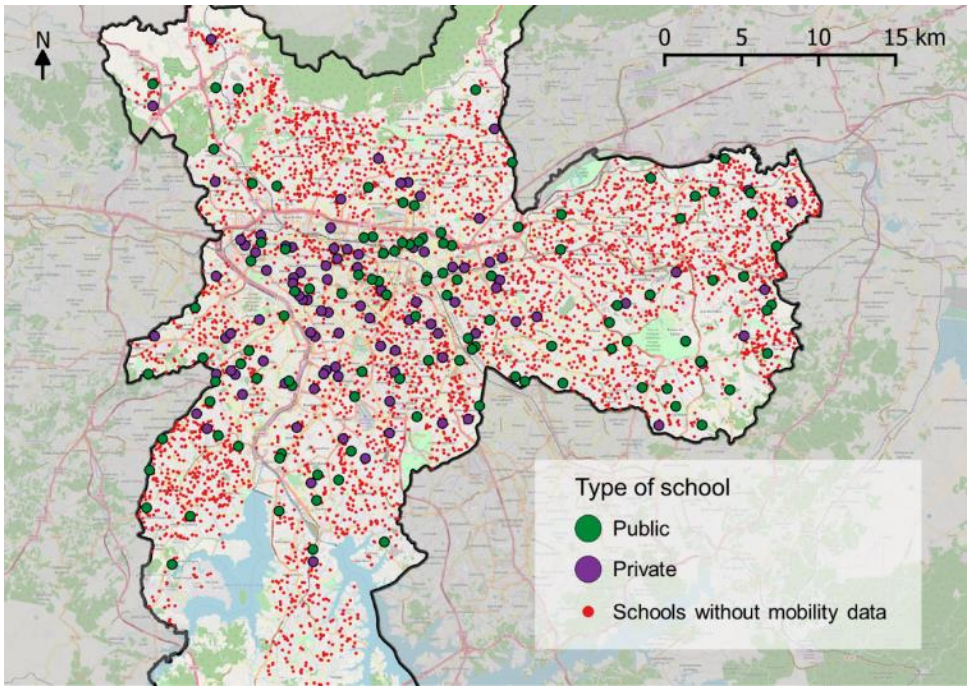

Figure 14: Spread of preschools and nurseries containing data on mobility (N = 204) according to type of school (public/private)

4.2.2. Road safety

The data on road safety for the surroundings of schools stemmed from the inventory of road crashes collected by the Municipality of São Paulo from 2009 to 2017 (N = 187,451). To identify the ones that are relevant to indicate the degrees of road safety around preschools and nurseries, only the pedestrian-car crashes during school drop-off and pick-up (weekdays at either 6:45am-7:15am, 4:45pm-5:15pm or 6:45pm-7:15pm) were filtered out, resulting in 12,885 cases. These were then intersected with the school surroundings (service areas of 2,000m) for the estimation of road safety in the school surroundings.

4.2.3. Built environment

The conditions of the built environment around schools were collected primarily from the decennial national census promoted by the Brazilian Institute of Geography and Statistics (IBGE), whose latest dataset (2010) was processed to collect a set of variables regarding the surroundings of schools. The levels of social vulnerability calculated by the SEADE Foundation (SEADE 2012) were also incorporated into the obtained service areas, as indicated in Table 14, as follows.

Table 14: List of measures on the built environment and respective description collected for the surroundings of schools (2,000m). Adapted from IBGE (2011) and SEADE (2012).

Measure	**Description**
Population density	Resident population in the school surrounding
Coverage of street lighting	Percentage of households with the presence of street lighting in the school surrounding
Coverage of paved streets	Percentage of households with the presence of paved streets in the school surroundings
Coverage of sidewalks	Percentage of households with sidewalks in the school surrounding
Presence of open sewage	Incidence (%) of open sewage near households in the school surrounding
Presence of litter	Incidence (%) of litter near households in the school surrounding

To incorporate the data from the census tracts to the limits of the school surroundings, the open-access QGIS intersection tool was used to identify which census tracts intersect with the limits of the surroundings, either partially or entirely. Absolute measures (*e.g.,* population, number of households, urban area) were calculated according to the areas of the intersected features, *i.e.,* the measures whose tracts are fully inserted in the school surroundings were summed without modifications, whereas the summation of measures whose tracts are partially inserted in the school surroundings were weighted by the ratio of the intersected area over the total area of the census tract. That enabled the computation of the relative measures, such as the population density (sum of the population of the intersected areas divided by the area of the service area) and the presence of litter (sum of the households with presence of litter in the intersected areas divided by the sum of all households in the intersected areas).

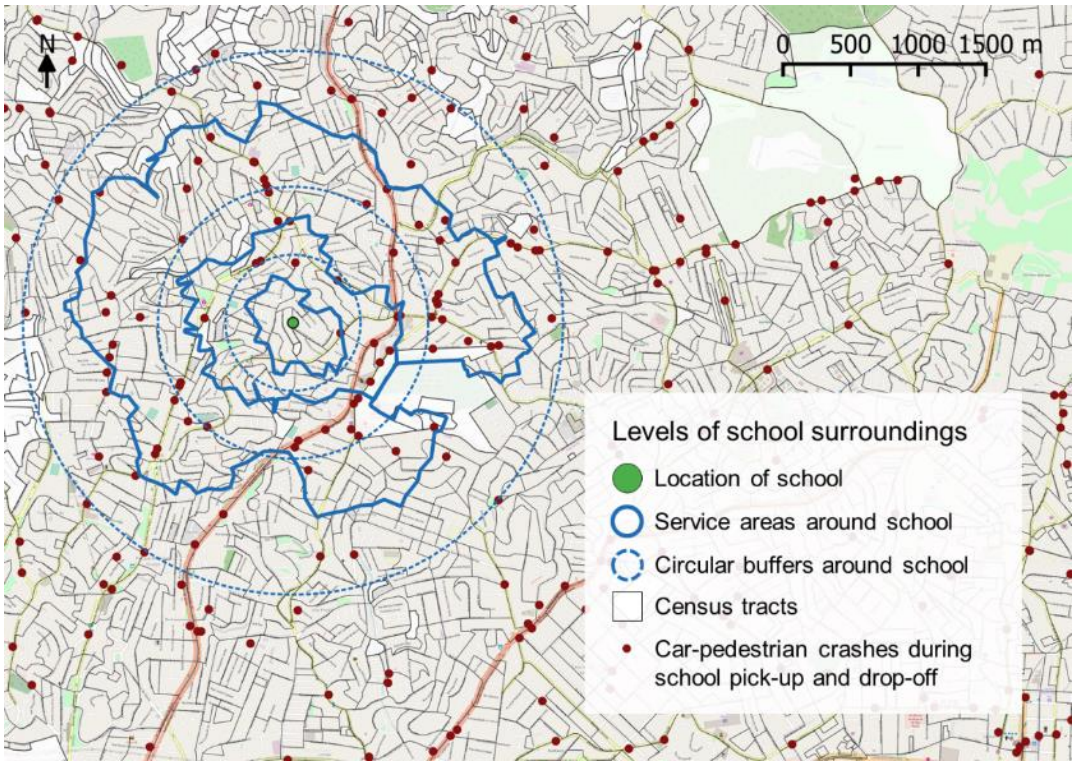

Figure 15: Circular buffers and service areas of selected schools (500m, 1000m, and 2000m): example of intersection of school surroundings with census tracts and road crashes.

In the first round of calculations, these measures were obtained for circular buffers and service areas of 500m, 1,000m, and 2,000m. However, as better explored in Humberto et al. (2018b), the scale of aggregation that best relates the conditions of mobility, road safety and built environment to children's transport is 2,000 meters around schools, which corresponds to a 30-minute walking distance for a preschool-age child. Furthermore, this distance (2,000m) is commonly adopted in Brazil as the threshold distance beyond which the school bus services are provided by the public sector (SME, 2018), which might therefore indicate relevant characteristics regarding the transport of children to and from school. In addition, service areas were also found to better address the conditions of children in accessing schools, as compared with buffers using Euclidean distance.

4.3. Methods

To compose the indicator of mobility capabilities of nurseries and preschools, some procedures were implemented to reconcile urban mobility quantitative methods with the concepts from the Capability Approach. In this study, the measurement of the CA metrics at the collective (school) level was pursued, which differs from the evaluation of individual well-being

that is commonly found in the literature (Robeyns, 2005). In addition, the adopted methods followed the perspective of emerging social movements and transport advocates in Latin America, which enact pedestrian mobility as the backbone of urban mobility towards the right to the city (Guimarães et al., 2019; Humberto et al., 2019; Vasconcellos, 2018).

The methodology is summarized schematically in Figure 16, as follows.

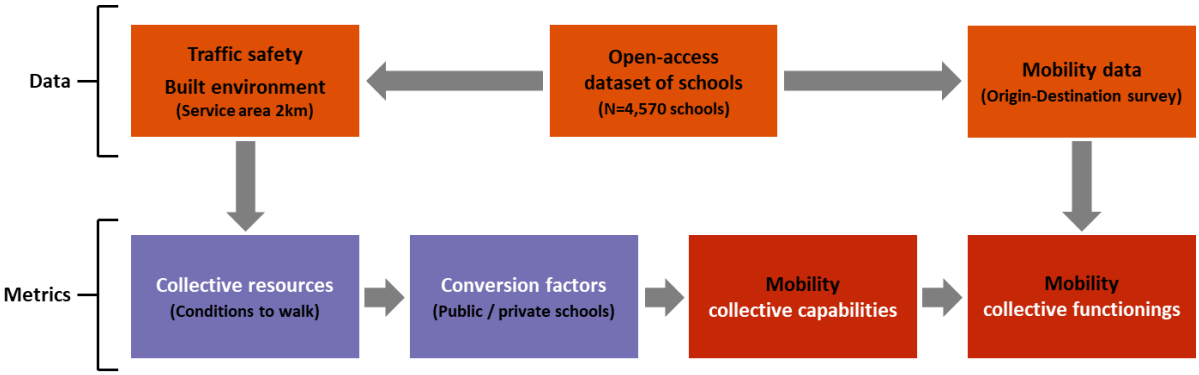

Figure 16: Schematic representation of the adopted methodological steps at the school (collective) level.

To obtain the measure of the mobility functionings, mobility data from the Origin-Destination survey was used: the share of pedestrian trips of the total number of trips of access and egress of each school. It was considered as the real practiced active mobility in a scenario where other types of mobility were also identified, like transit and other motorized modes.

On the other hand, mobility capabilities are represented by the potential of walking enabled by the conditions of school infrastructure surroundings. To achieve that, data on traffic safety and quality of the built environment (obtained for the service areas of 2,000m) was incorporated to compose a measure of resources, which here can be translated as the conditions to walk provided for the children and their caregivers. Then linear regressions were obtained with resources as the independent variable (conditions to walk) and the mobility functionings as the dependent variable (share of pedestrian trips to schools) to estimate the conversion factors that are the best estimates of the functionings given the resources that are provided in the surroundings of schools, considering the differences between public and private schools. Finally, mobility capabilities were then calculated by the multiplication of resources by the conversion factors. The following topics present details about these procedures.

4.3.1. Resources (Conditions to walk)

Considering the traffic safety and the selected variables of built environment as the factors that most influence the children to walk to school, the following method was developed to integrate these variables into a composite measure to indicate the resources of schools to promote active mobility.

First, the variables collected were classified according to their potential to indicate greater conditions for walking to and from school, *i.e.,* whether it is expected to influence positively or negatively the levels of active mobility. For example, greater population densities in the surroundings of schools might facilitate the promotion of walking to school (positive sign), while higher rates of road crashes might indicate lower levels of active mobility (negative sign). The definition of these signs is based on the literature review, on participatory surveys and the informed awareness of the local conditions by researchers.

For that, the relevant thresholds were identified for each metric to classify the schools in a binary way, *i.e.,* 1 (capable), and 0 (non-capable). When no references exist to specify thresholds of the component variables to encourage walking to school, a simplified criterium was adopted, *i.e.*, the median value of the variable and the expected correlation sign of each variable with the dependent variable (positive or negative). Accordingly, the expected correlation sign classified the schools above and below the median values as capable (1) or non-capable (0).

According to this procedure, the continuous values could be converted to binary values that are relevant for the appraisal of the conditions that might enable the achievement of walking to and from school. For the aggregation of the binary variables into a composite measure that aggregates the variables collected, equal weights were assumed for the two themes covered (traffic safety and built environment). For the metrics composing each theme, equal weight was also assumed, which varied therefore according to the number of metrics incorporated within each theme: only one for the traffic safety and six in total for the built environment. This can be summarized as follows.

$$Resources = \frac{Crashes}{2} + \left(\frac{Pop.\ dens.}{12} + \frac{Lighting}{12} + \frac{Paved}{12} + \frac{Sidewalks}{12} + \frac{Sewage}{12} + \frac{Litter}{12}\right)$$

The variables of population density and coverage of street lighting, paved streets and sidewalks were considered to influence positively the levels of active mobility, whilst for the presence of open sewage, litter, and occurrence of pedestrian-car crashes were considered to influence negatively the levels of active mobility.

This method is adapted from the measures proposed by Chakravarty and D'Ambrosio (2006) and by Biggeri and Libanora (2011) to calculate the deprivation score given by the sum of integer characteristic functions and to measure the multidimensional impact on children using the CA.

4.3.2. Conversion factors and mobility capabilities

Apart from capabilities and functionings, a third core idea of the capability approach regards the conversion factors, which determine the degree to which a person can transform a resource into a functioning, since persons have different abilities to convert resources into functionings (Robeyns, 2003). By seeking to adjust the capabilities for differences in needs, the conversion factors might "involve some extremely complex social issues, especially when the achievements in question are influenced by intricate intragroup relations and interactions" (Sen, 2006, p. 33), which complicates the selection of variables to be included. Instead, to enhance inter-units comparability of the capability measure, an equivalent measure of resources can be calculated for each unit, including all and sufficiently detailed information on needs to calculate the conversion factor (Kuklys, 2005). In fact, the formal description of the Capability Approach by Sen (1985, p. 13) describes it as a conversion function that maps characteristics of commodities into the space of functionings, allowing to a set of all possible conversion functions.

In the "conversion of these primary goods and resources into (...) combinations of functionings and other achievements" (Sen, 2006, p. 81), the conversion factors can represent how much functioning one can get out of a resource (Robeyns, 2003). In the case here presented, these might correspond to the share of active mobility that children in a specific school can get out of the conditions provided to walk in the school surroundings. Nonetheless, practical considerations make this task impossible, as there is lack of data and difficulty to distinguish conversion factors at the individual, social and environmental levels for the collectivity of schools. By focusing on the differences between public and private schools, an aggregate coefficient was proposed, representing the level of conversion of resources in functionings, as follows.

$$Resources \times \beta + \alpha \approx Functionings$$

To estimate the conversion factors (α and β) that best estimate the conversion of resources (conditions to walk) into functionings (share of pedestrian trips to school), ordinary least squares regressions (OLS) were run to investigate the relationship between the variables and to

identify the possible idiosyncrasies among public and private schools (Leßmann, 2012). Once the coefficients were obtained, all regression assumptions were verified, including the normal distribution of the resources (independent variable), the normality and non-autocorrelation of disturbances, and non-heteroscedasticity of disturbances with the predicted values (Washington et al., 2010).

Finally, the mobility capabilities were calculated by multiplying the resources by the conversion factors specific to the school type (public/private), representing the ability to access schools through walking once the characteristics of public and private schools are acknowledged.

$$Resources \times \beta + \alpha = Capabilities$$

That is nevertheless different from the realized mobility functionings (share of pedestrian trips), even though the regression parameters were obtained to be their best estimates. In this sense, the gaps between functionings and capabilities were calculated to assist in the identification of some dimensions of well-being that lead to major gaps between functionings and capabilities (J. Trani et al., 2011), even when differences between public and private schools were acknowledged.

$$Gap = Functionings - Capabilities$$

According to the presented formula, the gaps therefore refer to the errors in the regression model that occur irrespective of the school type (public/private), which can be either positive or negative. The sequence of the subtraction (Functionings - Capabilities) is suggested by the term "Gap between functionings and capabilities" as coined by Trani et al. (2011). In this sense, the positive and negative characteristic of the gaps between functionings and capabilities thus refers to the numerical and not to the semantic aspect of a positive/negative gap.

4.4. Results

Analyzing the scenario of the schools' surroundings in comparison with the city of São Paulo (Table 15), the population density and per capita income are slightly higher for the former, while the percentage of children (aged 0 to 6) is almost the same for both. Also, the percentage of the population with high social vulnerability is smaller for the schools' surroundings than for São Paulo. This outcome is likely to represent some bias of our sample towards better socio-economic conditions than the average of the city.

Table 15: Average values of selected measures regarding the surroundings of analyzed schools (service area 1000m) as compared to the average of the city of São Paulo. [a] extracted from CEM (2011).

Measure	**Average of school surroundings**	**Average São Paulo** [a]
Population density, urban area (pop./km^2)	14 078	12 165
Per capita income (R$)	1 454	1 128
Percentage of population aged 0 to 6	8.4%	8.9%
Perc. of pop. with high social vulnerability	11.7%	15.6%

The distribution of pedestrian trips obtained through the data of the Origin-Destination survey performed by METRÔ-SP (2008) is illustrated in Figure 17. The central and east regions of São Paulo show a higher share of pedestrian trips than in the West and the South, indicating lower shares of pedestrian trips along the economic and business expansion area in the southwest zone.

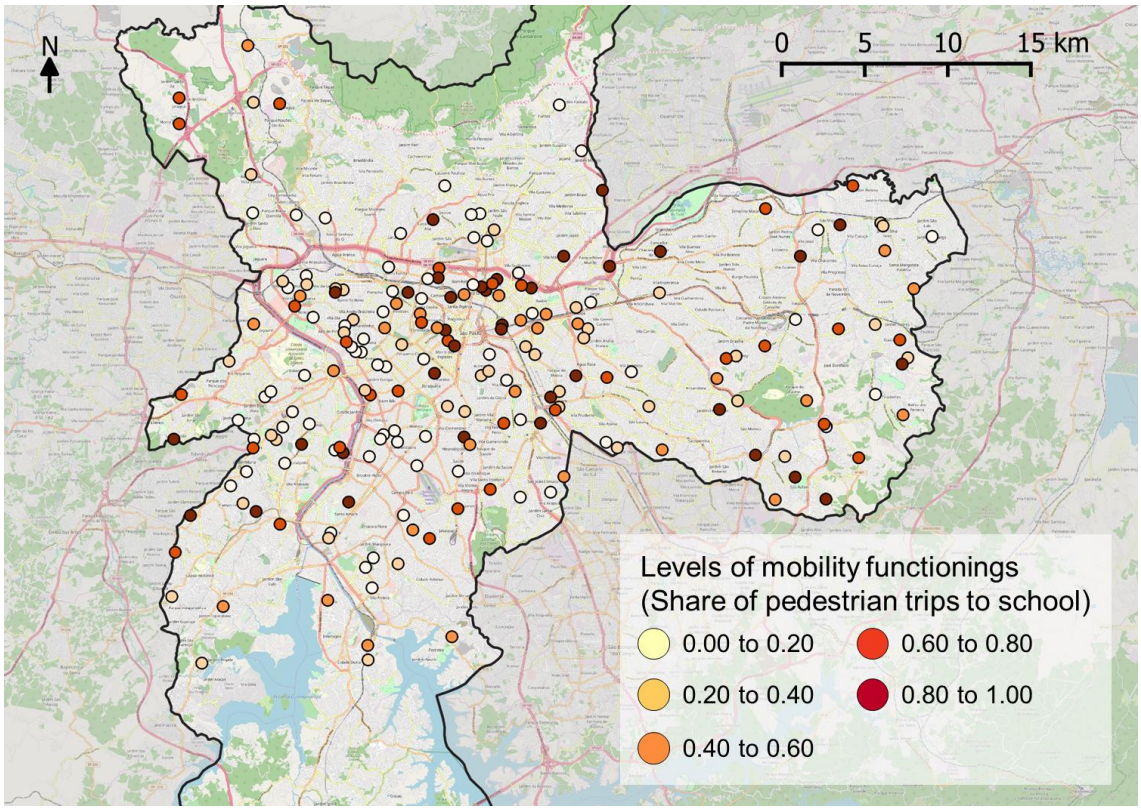

Figure 17: Levels of mobility functionings (share of pedestrian trips to school).

The ranges of resources seem to point out poorer conditions to walk where the share of pedestrian trips is rather elevated, especially in the schools located around the city center, in which there is a concentration of job opportunities, better public services and spaces (Alvarez, 2016; Dorothée et al., 2019). As indicated in Figure 18, lower values of resources can be generally explained given the composition of the metric, since half of it is composed by traffic safety, which is normally configured by greater traffic flows derived from the concentration of jobs and services. There are some exceptions to schools that present good conditions to walk in the outskirts, although this interpretation does not consider the differences between public and private schools. In any case, the opposite does not seem to apply in the same proportion, since it is not possible to identify schools presenting the lowest levels of resources in the economic and business area in the southwest region.

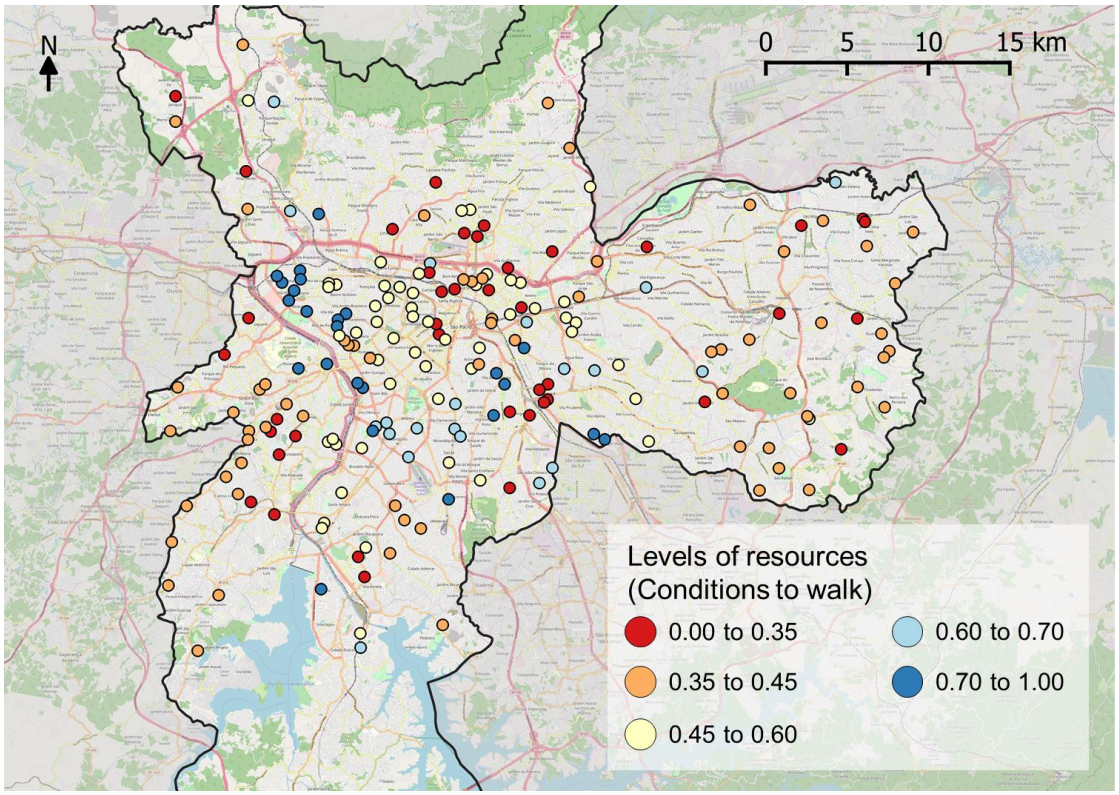

Figure 18: Levels of resources (conditions to walk) of schools.

Once computed into a simple linear regression model, the conditions to walk (independent variable) and the share of pedestrian trips (dependent variable) yielded parameters that enabled comparing the abilities to convert resources into functionings according to the school type (public/private).

Table 16: Coefficients of inserted dependent variables (above dashed line) and relevant goodness-of-fit measures (below dashed line). *** Regression coefficient is statistically significant at the 5% level; ** 10% level.

School type	**Public schools**	**Private schools**
(intercept)	0.680***	0.210***
Level of resources	-0.286**	0.091
Adjusted R^2	0.020	-0.006
Durbin-Watson [P-value]	1.916 [0.620]	2.056 [0.810]
F (ANOVA) [P-value]	3.279 [0.072]	0.408 [0.524]

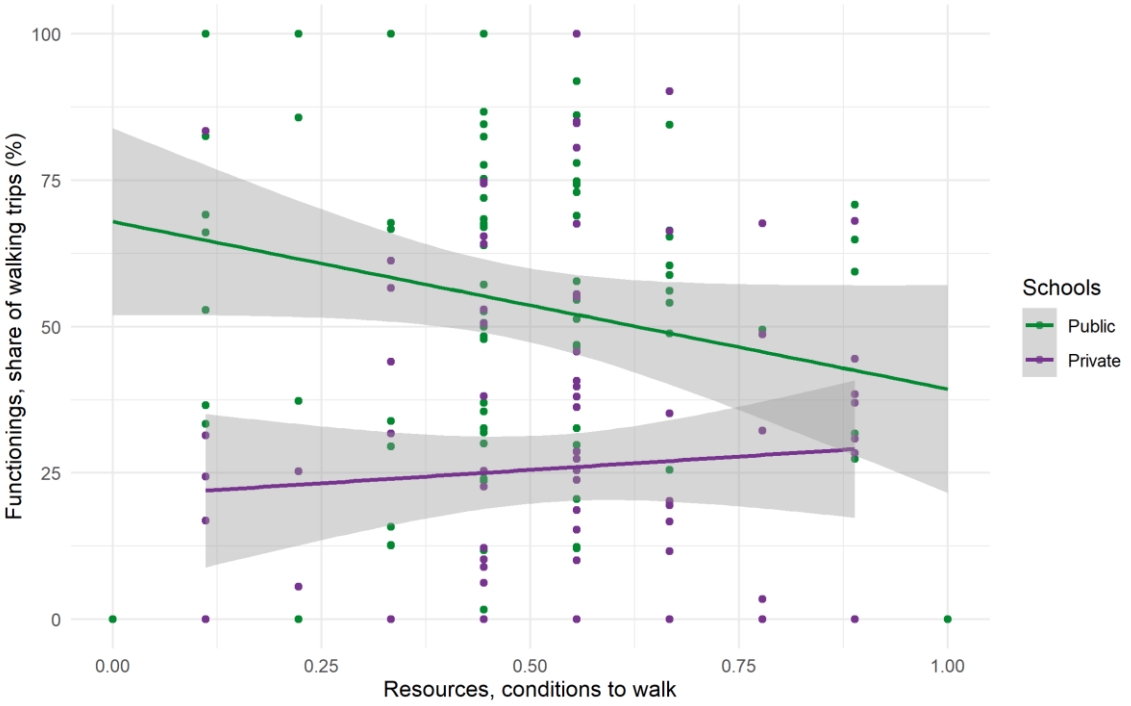

Figure 19: Relationship between resources and functionings and lines fit using linear regression (conversion factors) according to school type (public/private).

As indicated in Table 16 and Figure 19, the regression model obtained allows observing some marked contrasts between public and private schools. First, it indicates the different ranges of share of pedestrian trips the two school types tend to operate: public schools between 40% and 70% and private schools around 25%, *i.e.*, higher for public schools regardless of the conditions to walk. Second, the regression parameters present discrepancies when compared with the literature: in public schools there is a negative relationship between the resources and the functionings, *i.e.* the better the conditions to walk the lower share of pedestrian trips to school, which is statistically significant. On the other hand, in private schools there is a positive relationship between the share of pedestrian trips and the conditions to walk, which is aligned to the transport literature (Humberto et al., 2019; Moura et al., 2017; Sirard and Slater, 2008), however it is close to zero and is not significant statistically.

Regarding the verification of the linear regression assumptions, both models for public and private schools present normal distribution for both the resources and the disturbances[3], and there is no heteroscedasticity of disturbances with the predicted values. Regarding the non-autocorrelation of disturbances, indicated by values of the Durbin-Watson statistics around 2.0 (Washington et al., 2010), the models yielded values of 1.916 for public schools and 2.056 for private schools and thus indicating that no strong autocorrelation is present.

[3] Kolmogorov-Smirnov and Shapiro-Wilk tests for normality of distributions were all significant considering a 99% confidence interval.

From the resources and the conversion factors, it was able to obtain the mobility capabilities, which indicate the ability of children and their caregivers to access schools through walking given the conditions to walk and the intrinsic characteristics to convert the resources into achieved pedestrian mobility, according to the school type (public/private). Unlike the previous analyses regarding the mobility functionings and the resources, the distribution of the mobility capabilities (see Figure 20) does not seem to follow a clear geographical pattern, in which a diverse range of capability values can be found regardless of the distance to both the city center and the economic and business districts.

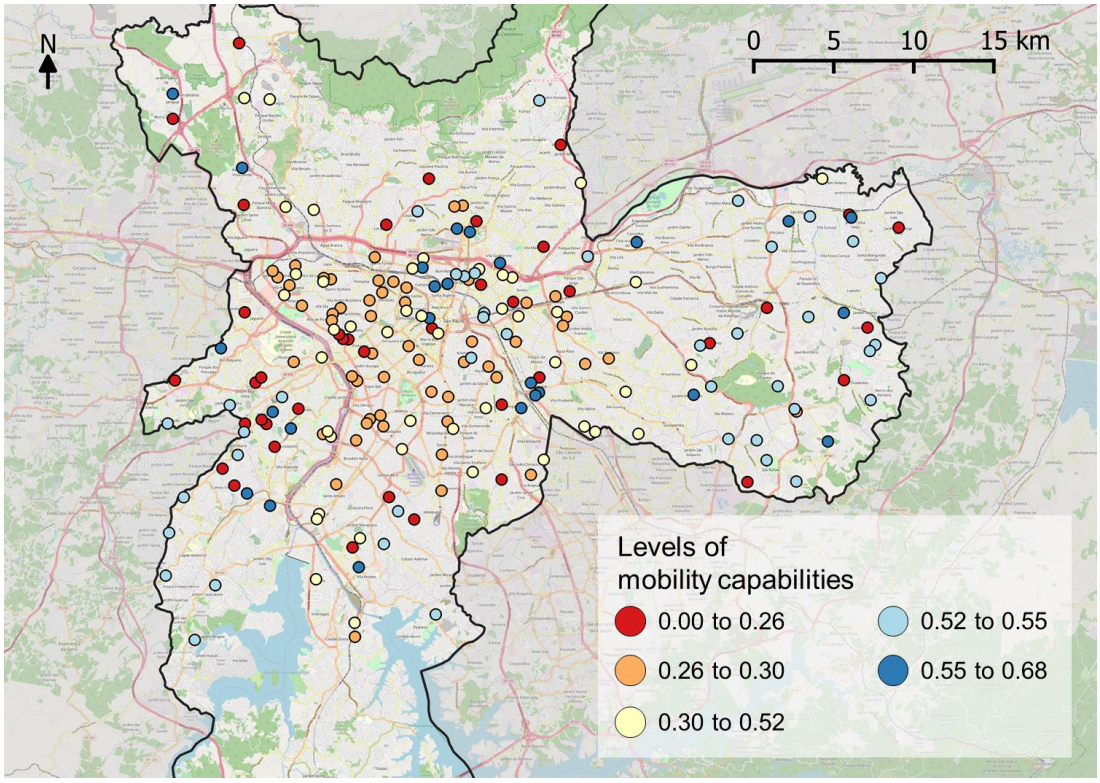

Figure 20: Levels of mobility capabilities.

Another configuration seems to apply to the distribution of the gaps between functionings and capabilities, which were calculated by subtracting the capabilities from the functionings. Although there does not seem to have a clear spatial pattern for positive or negative values of the gaps, there seems to be a concentration of negative gaps around the city center and the economic district. Negative gaps between functionings and capabilities indicate levels of functionings lower than the obtained from the multiplication of the resources by the conversion factors, which indicate that there are barriers to the fulfillment of active mobility, even when the conditions to walk are considered sufficient. This interpretation is similar to the gaps presented by Trani et al., (2011) to study the barriers between an individual's performance and her ideal

performance, in which some interventions are required to “extend the capability set of all members of the society by removing barriers to activities that people value” (Ibid.).

Conversely, positive gaps represent levels of functionings that lie above a school's ideal performance (given the resources in the school's surroundings and the school's conversion factor), which indicate a "surplus" of functionings given the school's capability. Although that might seem unreasonable, these positive gaps seem to apply concerning the access to schools through walking in São Paulo, in which children and their caregivers commonly do not have any other options than walking (e.g., transit, bicycle or private vehicle), even where there are poor conditions to walk (Pelegi and Quintáns, 2019). Such capability imbalances also seem to emanate whenever there are modifications in public services such as the free school bus, which is generally treated with disregard (Garcia, 2019).

The positive and negative gaps can also be explained by the fact that our method compared the share of pedestrian trips to school (functionings) with the conditions of the school surroundings on traffic safety and the built environment (resources) at the school level, in which individual conversion factors are not considered and the functionings can exceed the capabilities. Such mismatches can be considered a distinguished possibility to evaluate situations at the collective level whereby walking is the eligible mode even with conditions that are not so favorable, which may indicate situations where children and their caregivers are achieving functionings that they would not realize if there were other options to access schools, in which their freedom of choice to walk to school is undermined given the poor conditions to walk.

To better understand the gaps between functionings and capabilities (see Figure 21), its correlation with some socioeconomic and mobility variables were calculated. The results presented in Table 17 (below) indicate that lower incomes and higher levels of social vulnerability are positively associated with the gaps between functionings and capabilities. Additionally, higher proportions of white population were negatively correlated with the gaps, which reinforces the considerations previously presented regarding the population in most vulnerable situations that performs active modes in despite of poor conditions to walk. Mobility-related variables such as the walking time to school and the distance to metro stations did not present any statistically significant correlation with the gaps between functionings and capabilities.

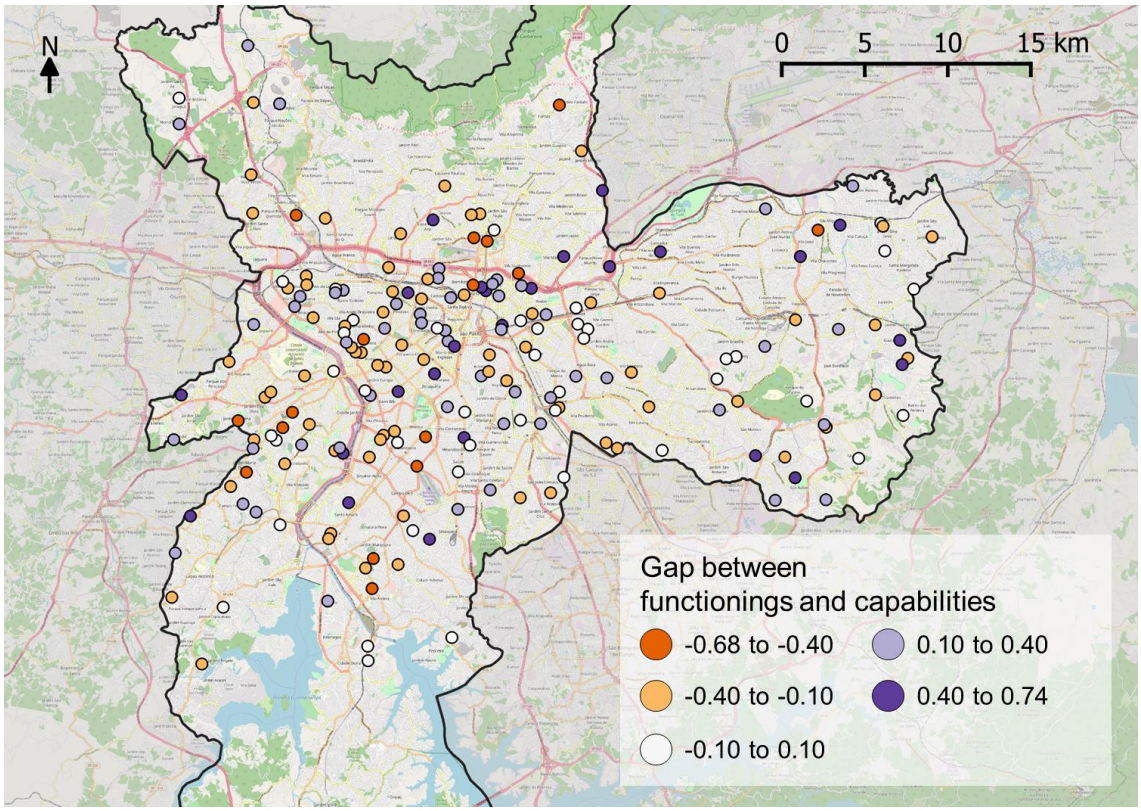

Figure 21: Differences between mobility functionings and mobility capabilities.

Subsequently, in order to identify relationships between the variables collected the difference of means between relevant groups was also compared: i) public schools (N=110) and private schools (N=94); ii) schools with poor and good conditions to walk (1st and 5th quintile, respectively); iii) schools with low and high gaps between functionings and capabilities (1st and 5th quintile, respectively); and iv) public nurseries (N=48) and public preschools (N=54), which are presented in Table 17.

The differences between public and private schools are remarkable: in public schools children tend to walk much more than in private schools (55% and 26%, respectively) and under poorer conditions, which is aligned with the transport disparities identified by Moreno-Monroy and colleagues (2018) between public and private schools and endorses the stratification of the analysis by school type. Additionally, in public schools there are lower incomes, higher social vulnerability, and fewer white people when compared to the private schools, which seems to corroborate with the class and race disparities in the access to education in Brazil (Osorio, 2009).

The comparisons according to the level of resources followed the same trend, in which the schools in poorest conditions to walk (lower quintile) had higher walking shares, lower incomes, higher vulnerability, and smaller white population. The same situation applies to the means between by higher and lower gaps between functionings and capabilities, in which positive gaps (higher quintile) were associated with lower social indicators. There seems to be a slight prevalence of public schools in the schools with poor conditions to walk (61%), which nevertheless is not found between higher and lower gaps between functionings and capabilities.

Once public nurseries and preschools are compared, it is possible to capture the idiosyncrasies associated to the age of children (nurseries 0-3y, preschools 3-6y) and the role of specific public policies. Private schools could not be incorporated in this analysis, since most of them cover both age ranges (0-6y), unlike most of the public schools. No significant differences were found regarding the social indicators and the conditions to walk. On the other side, the share of pedestrian trips was higher among nurseries, followed by greater gaps between functionings and capabilities. The means between nurseries and preschools presented opposite values, i.e., positive for nurseries and negative for preschools, indicating the existence of some barriers to the fulfillment of active mobility in preschools, whereas in nurseries the children and their caregivers might not have any other options than walking to go to school, even when the conditions to walk are poor. The influence of younger children does not seem applicable to explain the higher shares of pedestrian trips and gaps found in nurseries, and the correlates of the child age with active school transportation are imprecise (Sirard and Slater 2008). However, such gaps might be correlated with the provision of free school buses by the municipal government, which are restricted to children in preschools and older students in primary and secondary schools (SME 2018). Although it is a limited service and does not cover the majority of children in public preschools, that is not even an option for caregivers with children in public nurseries, which depend on nurseries to look after their children as they work and generally cannot rely on transit, bicycle or private vehicle to take their children to school. This difference between the public nurseries (positive gaps) and the public preschools (negative gaps) should nonetheless be considered with caution, since the values are close to zero and they are statistically significant at the 20% level only.

The differences in the mobility-related variables were only found between public and private schools, in which public schools present longer distances to metro stations and longer walking times. Such disparities were not found when the other groups are compared: poor/good conditions to walk; negative/positive gaps; and nurseries/preschools.

Table 17: Pearson coefficients of correlation and comparison of means of selected variables between public schools (N=110) and private schools (N=94); schools with poor and good conditions to walk (1st and 5th quintile, respectively); low and high gaps between functionings and capabilities (1st and 5th quintile, respectively); and between public nurseries (N=48) and public preschools (N=54).

Measure	**Correlation with gap between functionings and capabilities**	**Comparison of means**			
		Public / private schools	**Poor / good conditions to walk**	**Low / high gaps between funct./capab.**	**Nurseries / preschools (public) [a]**
Share of pedestrian trips	0.897 ***	55% / 26% ***	43% / 34% *	6% / 89% ***	60% / 51% *
Conditions to walk	0.000	0.470 / 0.527 ***	0.201 / 0.775 ***	0.536 / 0.447 ***	0.454 / 0.475
Gap funct./capabilities	-	-	-0.035 / -0.026	-0.378 / 0.443 ***	0.047 / -0.038 *
% of public schools	-	-	61% / 45%	60% / 61%	-
Per capita income (R$/hab.)	-0.114 *	1,372 / 2,302 ***	1,101 / 2,622 ***	2,148 / 1,429 ***	1,234 / 1,440
Perc. of population with high social vulnerability	0.126 **	12.5% / 6.6% ***	15.6% / 2.7% ***	6% / 12% **	12.9% / 13.0%
Percentage of white population	-0.151 ***	65% / 75% ***	63% / 79% ***	74% / 65% ***	64% / 65%
Average walking time to school (min)	0.064	15.7 / 12.0 ***	13.9 / 13.3	16.9 / 15.6	15.9 / 14.9
Distance from metro station (m)	0.031	3,542 / 2,678 ***	3,198 / 2,669	2,846 / 3,115	3,352 / 4,077

*** Pearson correlation or T-Test for difference of means is statistically significant at the 5% level; ** 10% level; * 20% level. Equal variance is not assumed for T-Test. [a] Integrated preschool & nursery schools (N=88, 80 of them are private) were not considered in the analysis.

4.5. Discussion

In the study presented in this section, a set of variables was collected for the surroundings of 203 preschools and nurseries in São Paulo (Brazil). That enabled the development of a measure of the conditions to walk covering two themes (traffic safety and the built environment), and the assessment of the pedestrian share of trips in the access to schools. Once related, the conditions to walk (resources) and the shares of pedestrian trips (functionings) allowed the computation of the conversion factors that estimate the conversion of the resources into functionings through a linear regression model, taking into account the differences between public and private schools. Finally, the mobility capabilities were calculated by multiplying the resources by the conversion factors specific to the school type (public/private), representing the ability to access schools through walking once the characteristics of public and private schools are acknowledged.

The estimation of conversion factors, though being an aggregate coefficient, highlighted the idiosyncrasies related to public and private schools on the conversion of resources into functionings at the collective level. Private schools presented a low share of pedestrian trips (around 25%), regardless of the conditions to walk, and the public schools tended to walk more (between 40% and 70%), presenting nevertheless a negative relationship between the resources and the functionings. The apparent detachment of walking with the built environment conditions in private schools and the negative association of walking with better conditions to walk in public preschools is not in line with the conventional literature on school transportation (Babb et al., 2016; Sirard and Slater, 2008). Nevertheless, these characteristics are aligned with the transport disparities in school transportation in São Paulo (Moreno-Monroy et al., 2018), inasmuch as the choice to walk in private schools is not associated to the available resources, but rather to the availability of other transport modes such as public transportation and the private car. On the other hand, children and their caregivers in public schools might be achieving functionings that they would not realize if there were other options to access schools, particularly when the conditions to walk are poor. That provides a clear picture of the resources and the conversion factors needed to walk to school at the collective level, which "gives those aiming to expand capability sets information on where interventions can be made" (Robeyns 2003) and seems to resonate with the findings concerning the gaps between the functionings and capabilities.

Albeit accounting for differences between public and private schools, the realized mobility functionings (share of pedestrian trips) presented gaps when compared with the calculated capabilities, which helped to identify some barriers to the fulfillment of active mobility, even when the conditions to walk are considered sufficient (negative gaps), and the situations in

which children and their caregivers do not have any other option than walking in places with poor conditions to walk (positive gaps). Positive gaps are associated to schools with lower incomes, higher social vulnerability, and located in neighborhoods with fewer white people, which seems to corroborate with the class and race disparities in the access to education in Brazil (Osorio 2009) and might reflect the lack of alternatives to walking to access schools, even where there are poor conditions to walk (Pelegi and Quintáns 2019). Correspondingly, negative gaps seem to be concentrated around the city center and the economic district, which indicates barriers to the fulfillment of active mobility, even when the conditions to walk are considered sufficient. These barriers among children in private schools may be related to the socioeconomic status associated with private car use, inflated perceptions of public security, and even the conditions of access imposed by some of these schools, with part of them facilitating the access of the private car to its facilities and complicating the access and parking of active modes such as the bicycle.

Those remarks can be helpful when drafting public policies to promote walking as a primary way to access public and private schools. Positive gaps between functionings and capabilities suggest prioritizing the upgrading of existing pedestrian trips to school that are performed under inadequate conditions. Particular attention may be paid to public nurseries, in which the absence of a free bus service by the municipal government seems to intensify the situation of children and caregivers that are compelled to walk in poor conditions. In the other way, negative gaps indicate a better match of strategies for promoting walking (e.g., marketing, advocacy, campaigns) in regions with a low pedestrian share of trips and a rather consolidated infrastructure.

The adopted aggregation method to compose the conditions to walk was found to be appropriate to measure the resources that seem relevant to walk to school. The method differs from the additive compensatory ones that are commonly applied in the development of multicriteria indexes in the transport domain, since the aggregation of binary variables into a composite measure adopted in this study minimizes the compensation of a metric's low performance by a high score by another metric..

The empirical contribution of this work is expected to encourage the intersection of scientific domains such as transportation, social justice, education, and childhood studies, in which a transdisciplinary understanding is increasingly needed. Especially in the transportation field, the proposed methods to estimate the resources, capabilities, and the conversion factors are believed to endorse further analyses about the disparities between the potential and the achieved mobility at the collective level, since most of the studies focus uniquely on the measurement of outcomes (functionings).

In addition, it seems that the application of the CA at the collective level has enabled capturing some of the observed functionings of children and caregivers (at the school level) to collectively overcome difficulties as they walk to schools, especially in the case of schools whereby walking is the eligible mode even with conditions that are not so favorable. In this sense, the proposed empirical application at the school level seems appropriate as a preliminary assessment of the capabilities of children and their caregivers regarding their daily transportation to school, especially in contexts of large scale and data scarcity. That nevertheless does not seek to replace analyses at the individual level, which should be the ultimate level of analysis.

5. Incorporating children's views and perceptions in travel behavior research through the Philosophy with Children inquiry approach

This section seeks to explore the experiences of incorporating children's views and perceptions about their daily mobility, focusing on structured approaches for data collection and analysis that seek to understand the social and spatial dimensions of young children as they move in the city. It stems from the empirical research conducted together with 5 to 6-year old children and their caregivers in three public preschools in São Paulo (Brazil) with a high prevalence of low-income immigrants, using the "Philosophy with Children" (PwC) inquiry approach.

Previous versions of the work presented in this chapter have appeared in the following conference and publications:

- XIX ICPIC Biennial Conference. Bogotá (Colombia). July 2019 (Barreiros et al., 2019b);

- Praxis & Saber, Volume 10, Issue 23 (Barreiros et al., 2019a);

- Travel Behaviour and Society (Currently under review). Submitted February 2020. Available as preprint (*Cf.* Humberto et al., 2020a).

This section is associated to key research question number 2 (K-RQ2) and respective specific objective (S-O3) and specific research questions (S-Q9 and S-Q10). See Table 1, Table 2, and Table 3 (section *1.1. Objectives and research questions*) for further details on the association of key research questions (K-RQ) with the specific objectives (S-O) and specific research questions (S-RQ) of this doctoral research.

5.1. Highlights

- Young children (aged 5-6) can provide valuable insights about transport-related topics;

- Potential of the Philosophy with Children inquiry approach to capture perceptions from the point of view of children;

- Motorized transport is associated to more negative comments about urban mobility;

- Influence of nationality and social vulnerability on children's views on transport;

- Topic modelling and sentiment analysis are suited to analyze qualitative data from younger children.

5.2. Methods

In this section, the methods of data collection and analysis are presented. The description and context of children and schools involved in this study are presented in the section *5.3. Results*.

5.2.1. Data sources

The data to analyze the perceptions of children about urban mobility stem primarily from the transcripts of the inquiry sessions about urban mobility, which are associated to questionnaires completed by the children's caregivers. It is therefore possible to associate what children said to their household context, based on the responses to these questionnaires. These sessions are built on the concepts of the Philosophy with Children (PwC) inquiry approach, which "thinks of philosophy not as knowledge or content but as a relationship with knowledge and thought" (Kohan, 2015). In this sense, the PwC approach focuses on "creating the conditions to philosophize", which means that everyone sits in a circle, asks for the floor to speak and promotes the relationship between the participants of the inquiry sessions (*Ibid.*). As mentioned in section 3.5.1, the "experiences of thinking" proposed by the PwC practices typically combine five methodological steps: i) gathering of collective questions and inquiries (initial setting); ii) experience (reading) of a text; iii) problematization and inquiry about the text; iv) raising of relevant themes and questions. and v) selection of themes and questions to keep discussing in the following PwC sessions (Gomes, 2019). In addition, a typical application of PwC involving younger children up to seven years old incorporates the *community ball* to give the "opportunity to call and be called upon by their peers" and sitting in a circle, which "nurtures collaboration amongst the children, helping them to be more focused on the topic", creating a safe place for philosophical inquiry (Jackson and Oho, 1993). A recent application of PwC about urban mobility with young children involves the discussion of "themes related to mobility and permanence in the public space, such as going from home to school, playing in the garden and going out to open spaces" (Barreiros et al., 2019a).

In this study, a set of 11 different PwC sessions was built by a group of four researchers together with children and staff from the participating schools, which involves aspects of urban mobility from the point of view of children. As referred above, the transcripts of these sessions are associated to the questionnaires filled by the caregivers two weeks before the beginning of the PwC sessions and cover a set of socio-demographic variables, such as age, gender, family size, location of residence/work, and the usual transport modes to/from school (N=232).

Information about the nationality of children and their caregivers was provided by the school staff. Finally, the georeferencing of the children's households as provided by the caregivers enabled the association with public datasets about the housing conditions, including the insertion into squatter settlements and slum areas (HabitaSampa, 2019) and the determination of social vulnerability levels (SEADE, 2012). As previously indicated in section 3.5.3, the data collection and processing were approved by the Research Ethics Committee of the Institute of Psychology at the University of São Paulo (CEPH-IPUSP) on December 2018.. The doctoral candidate was part of the group of researchers that coordinated the PwC sessions in the schools involved.

The transcription of the PwC sessions yielded a text corpus with 38,369 segments of text, corresponding to comments of the participants during the PwC sessions, both for children and adults (school staff and participating researchers). Each segment of text is composed by the code of the participant, the number of the related PwC session, and the transcription of the spoken participation during the PwC sessions, which can vary from short comments to long contributions to the discussions at stake. In this study, the sessions whose record is predominantly non-textual (*e.g.* drawing sessions and sound installation) are filtered out, as well as the introductory and closing PwC sessions (*cf.* Table 12, section 3.5.1.1, for a detailed description of the implemented inquiry sessions), which yields a dataset composed by 27,943 segments. 49% of such segments refer to narratives made by children and 28% of them (N=7,934) are associated to the data provided by the questionnaires to caregivers, which corresponds to the dataset used in this study.

5.2.2. Data analysis

The methods for processing the collected data are largely based on a set of statistical and data science tools developed within R (version 3.6.1). To handle the data collected in the PwC sessions, two different approaches for analyzing qualitative data were implemented: topic modelling and sentiment analysis. While both methods stem from linguistics and computational sciences, topic modelling (also known as Latent Dirichlet Allocation or LDA models) are probabilistic models for extracting semantic information from collections of text documents, in which the topic model "learns a set of thematic topics from words that tend to occur together in documents" (Newman et al., 2010). On the other hand, sentiment analysis (also known as opinion mining) seeks to determine the polarity of pieces of text by classifying terms generally as positive or negative, based on predetermined sentiment lexicons (Cambria et al., 2013).

In this study, the underlying topics of the PwC sessions are identified using LDA models from a set of functions within R. First, each segment of text is split in their component words (also known as terms or tokens, using the *tidytext::unnest_tokens* function), the stop words are removed (*tm:stopwords*), then casted into one-token-per-row table called Document Term Matrix (also known as DTM, *tidytext::cast_tdm*), representing the word frequencies during the PwC sessions. Subsequently, a set of LDA models is tested (*topicmodels*::*LDA*, *method = "Gibbs"*) using a number of topics (K) between two and ten. The chosen model (K=6) is thus selected according to two criteria: i) the alignment of the generated topics to the proposed PwC sessions; and ii) the sample size of per-topic-per-word probabilities (beta) when stratified in relevant groups (greater than 30). That results in a reduced dataset with 1,116 terms (tokens) for each of the resulting topics.

To determine the polarity of the children's statements using sentiment analysis, two lexicon-based methods are used: i) the AFINN lexicon, composed by 2,477 terms scored in integer values between -5 and -1 for negative words and between 1 and 5 for positive words (Nielsen, 2015); ii)) the Bing lexicon, which uses a binary classification of 6,786 terms in either negative or positive terms (Bing, 2015). Both lexicons are largely composed by negative terms (65% AFINN, 70% Bing). To calculate the polarity of the children's statements, the segments of text are associated to the AFINN and Bing lexicons (*tidytext::get_sentiments*) once the segments are tokenized and the stop words are filtered out. That yields a dataset composed by 2,292 and 2,371 tokens associated to the values in the AFINN and Bing lexicons, respectively. Once tokens are reassembled into the corresponding segments of text, 1,909 and 1,929 segments of text are obtained using the AFINN and Bing methods, respectively.

In this sense, the association of the PwC transcripts with the questionnaires to caregivers enables the investigation of the main topics and the polarity of the children's statements according to relevant groups, for instance the nationality of the child, the home-school distance, and the usual transport mode to school. To achieve this, in topic modelling the prevalence of a chosen topic is compared between two groups, which is calculated by summing up the betas for each of the groups and is represented in percentage (%). In sentiment analysis, the average polarity of terms used by children from different groups is compared through the Welch two sample T-test for difference of means (*stats::t.test*).

5.3. Results

The children whose statements about urban mobility are analyzed in this study come from three public preschools in the city of São Paulo (Brazil). Despite being located within a region known as the "Expanded Center" (*Centro Expandido*) that concentrates most of the jobs and public facilities in the municipality (health, education, transport, culture, etc.), the surroundings of the analyzed schools are characterized by poor housing conditions and the concentration of low-income immigrants working in the clothing and textile sector, predominantly from Bolivia (Pucci, 2013). That seems to be convergent with the study sample, which despite presenting a smaller proportion of the population living under high social vulnerability[4] (*e.g.* within slums and squatter settlements), it points to lower incomes when compared to the whole municipality (see Table 18). Moreover, 44% of the analyzed children live in households composed by non-native caregivers (68% of them from Bolivia).

Table 18: Average per capita monthly income and share of population in low/high social vulnerability in the study sample (N=232) and in the municipality of São Paulo. [a] Extracted from CEM (2011). [b] Extracted from SEADE (2012).

	Study sample	**São Paulo**
Average per capita income (R$/month) [a]	1 557	1 936
Share of low/high social vulnerability [b]	55% / 10%	52% / 16%

The high prevalence of non-native caregivers (mostly Bolivian) is not followed by the children, of which 86% are Brazilians (82% of non-native children are from Bolivia). The average home-school distance is 1.55 km, although the coefficient of variation (CV) greater than 1 and the median around 1.2 km suggest that there are outliers with longer home-school distances. The modal share to school is predominantly active (61% walk or bicycle to school), slightly higher than the average share of pedestrian trips in the remaining public preschools of São Paulo (54%, *cf.* Humberto et al., 2020b).

As indicated in Table 19, the use of active modes in school transportation seems to be biased towards non-native children and girls (once compared to natives and boys, respectively). Furthermore, children living in poor housing conditions seem to massively adopt active

[4] The metric of social vulnerability here adopted is the one calculated by the SEADE state agency to classify the territories in the State of São Paulo in six levels, which are here summarized in three groups: i) low (extremely low and very low social vulnerability); ii) average (low and average); and iii) high (high and very high). These are calculated using data from the national census such as literacy, employment, and the presence of younger children aged 0-5 y/o (Schumann and Moura, 2015; SEADE, 2012).

transport to school (83% *vs.* around 55% in low/average social vulnerability). The home-school distances of children adopting active school transportation are around 1 km. Among the children who walk the distance is approximately 0.8 km (Mean: 1.22 km, CV: 1.81, Median: 0.79 km), which corresponds to a 16 min walk by a preschool-age child and is similar to the walking travel time in public preschools in São Paulo (15.6 min, *Ibid*.).

Table 19: Descriptive statistics of the study sample. Distribution of categorical and continuous variables in the general sample (N=232) and description of children adopting active transport modes to school (N=140). [a] active: walking or bicycle; motorized: car or motorcycle. Multiple response question.

Variable	**Distribution**	**Adoption of active transport to school [a]**
Transport mode to school [a]	61% active / 22% motorized	-
Gender of child	47% girls / 53% boys	64% of girls / 57% of boys
Nationality of child	86% native / 14% non-nat.	59% of native / 68% of non-nat.
Nationality of caregivers	56% native / 44% non-nat.	29% of native / 23% of non-nat.
Age of caregiver	Mean (CV): 33.4 (0.27); Median: 32	Mean (SD): 32.2 (8.4); Median: 31
Home-school distance (km)	Mean (CV): 1.55 (1.25); Median: 1.16	Mean (CV): 1.24 (1.62); Median: 0.96
Level of social vulnerability	55% low / 35% average / 10% high	61% of low / 47% of avg. / 83% of high

5.3.1. Collection and labelling of topics

As indicated in section *5.2. Methods*, the extraction of semantic information from the PwC sessions was carried out using LDA models. The chosen model contains six topics (K=6), which was selected considering the alignment of the generated topics to the proposed PwC sessions (*cf.* Table 12, section 3.5.1.1) and the presence of these topics in the children's statements across relevant groups (for instance girls and boys, native/non-native children, transport modes adopted, and the levels of social vulnerability). The obtained topics and respective word probabilities in the PwC sessions can be found in Figure 22.

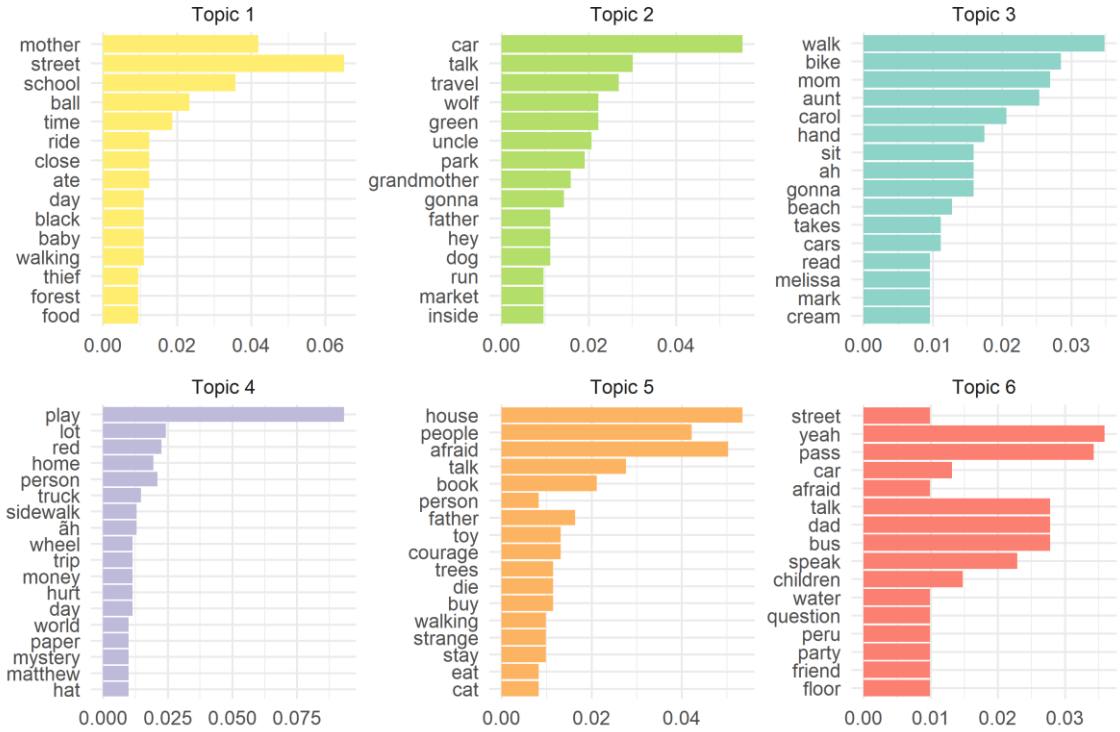

Figure 22: Topic-specific word probabilities in the PwC sessions as extracted through Latent Dirichlet Allocation (K=6 topics).

The splitting of topics in their component words resulted in a dataset with 1,116 terms (tokens) for each of the obtained topics, associated to their per-topic-per-word probabilities (beta). Then, topics are manually tagged to generate topic labels, in which the following principles are pursued: i) semantically relevant to the topic; ii) understandable to the user; and iii) covering the meaning of the topic, which is aligned with previous research in topic modelling (Allahyari et al., 2017). The topics' labels and sample text segments corresponding to the topics can be found in Table 20.

Table 20: Labelling of topics in the PwC sessions and examples of segments of text with highest per-topic-per-word probabilities (beta).

#	Topic	Example (segment of text)
1	Way to school	*I leave the school and go there, then I go and cross the street, then another avenue and another street, then another avenue, then I cross the street.*
2	Travel (general)	*I can't travel by car because I only travelled by car, not by plane.*
3	Joy / family	*When I went to my grandmother's house, I rode my bike and asked my grandfather to take the training wheel off.*
4	Play / risk	*Children play because you can play with friends, you have to call your friends to play. And I like to play climbing with my friend.*
5	Fear (home)	*When I stay home I always dream that it's there. I'm afraid it might catch me. When I get close to the stairs I get very afraid of that.*
6	Fear (street)	*We must watch the street so the cars don't run over us, we have to check if the light is red, otherwise the cars run over us.*

The topics obtained seem to cover relevant aspects related to the experience of urban mobility from the point of view of children, which is not restricted to the places and itineraries commonly reported in school transportation, for instance the home/school environment and the travel to/from school. Instead, they seem to encompass comprehensive issues that seem relevant to younger children when talking about urban mobility in the PwC sessions, such as the experiences of joy in the family (Topic 3) and the practices of play and risk (Topic 4). Through topic modelling, segments of text indicating perceptions of fear can likewise be captured, including those perceived at home (Topic 5) and others involving outdoor experiences and road safety (Topic 6).

Once topics are generated and labelled, it is possible to evaluate the prevalence of topics according to relevant groups (*e.g.*, gender, nationality, home-school distance) and compare them with the results from sentiment analysis.

5.3.2. Polarity and topic distribution in the PwC sessions

As a complement to the topic analysis described in section *5.3.1. Collection and labelling of topics*, the polarity of the children's statements was determined using two lexicon-based sentiment analyses, namely the AFINN and Bing lexicons. The former scores terms in integer values between -5 and 5, while the latter classifies the terms in a binary way (positive/negative).

Most of the terms used by children in the PwC sessions are classified as negative by the adopted lexicons: 60% in the AFINN lexicon (-5 to -1) and 73% in the Bing lexicon. That is in line with the composition of the lexicons (65% AFINN, 70% Bing). Regarding the distribution of topics in the PwC sessions, there is a relatively similar distribution of topics between 15% and

20%, with few mentions of Topic 1 (Way to School, 6%) and a slight predominance of a generalist Topic 2 (Travel general, 28%), as indicated in Figure 23.

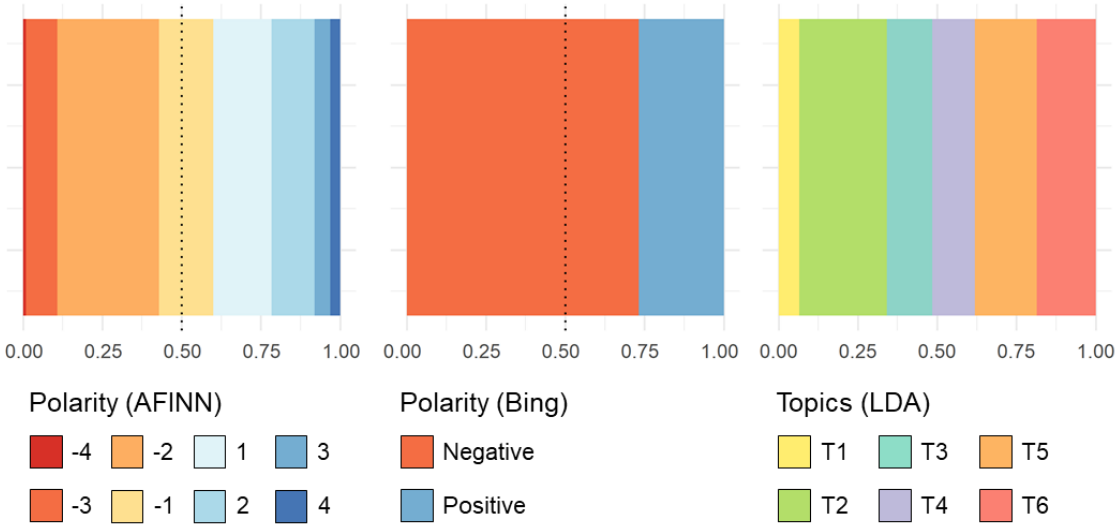

Figure 23: Polarity of terms (AFINN+Bing) and distribution of topics (LDA) in the PwC sessions.

When the polarity and the topics are stratified by the adopted transport mode to school (as stated in the responses by the caregivers to the questionnaire), it is possible to acknowledge some idiosyncrasies of the children's statements related to transportation (please refer to Figure 24). Unlike walking, cycling seems to be less negative than the other transport modes, especially when the Bing lexicon is considered in sentiment analysis. Although children using motorized modes seem to articulate statements with lower polarity, that does not seem to be significant when compared with the other modes. In topic modelling, it is possible to identify a higher prevalence of the Topic 4 (play/risk) in children using public modes of transport, whilst among the children using car and motorcycle to go to school it is possible to highlight a higher prevalence of Topic 2 (Travel general) and the non-existence of the Topic 1 (Way to school). That seems to be consistent with the characteristics of such transport modes, since the public modes of transport tend to present higher travel times and might bring other children of the same age group together on the journey to school (especially in the school bus). On the other hand, children using private motorized modes tend not to have any companions other than drivers or adults, which seems to affect the way children talk about their way to school and prompt statements about travel either fantastically (e.g. space travel, magic carpet) or in a generalist way.

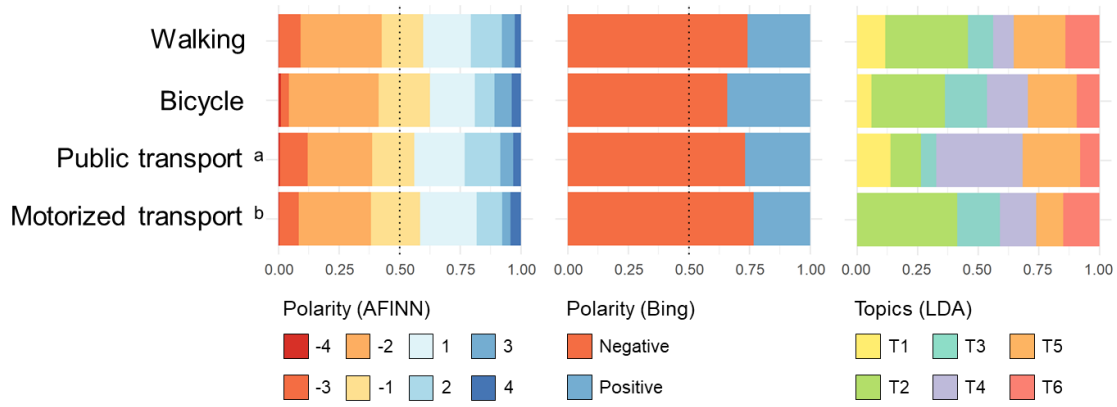

Figure 24: Polarity of terms and distribution of topics, stratified by the adopted transport mode to school. [a] School bus, public bus, or rail (subway and suburban train). [b] Car and motorcycle.

When observing the influence of some sociodemographic variables on the polarity and topics of the children's statements (see Figure 25), some features can be outlined. The nationality of children seems to have a significant role in the PwC sessions, since the statements from non-native children are more negative (mainly in the AFINN lexicon) and tend to refer more to family-related issues that occur within the household (Topics 2 and 5) when compared to native children, who seem to report statements about travel, play, and about the street and outdoor activities more frequently (Topics 2, 4, and 6). Similarly, higher levels of social vulnerability seem to have an even more pronounced impact on the polarity of children's statements, with considerably lower values using both AFINN and Bing lexicons. In topic modelling, the prominence of the generalist Topic 2 might reflect the lack of subjects related to urban mobility, followed by the absence of statements about Topics 1, 4, and 5. The perceptions about fear of the street (Topic 6) are nonetheless similarly prevalent in both high and low social vulnerability groups.

That is convergent with the characteristics of the selected schools' surroundings (poor housing conditions and precarious working conditions for immigrants), which seem to have a significant effect on children whenever they share their opinions and perceptions about urban mobility in the PwC sessions.

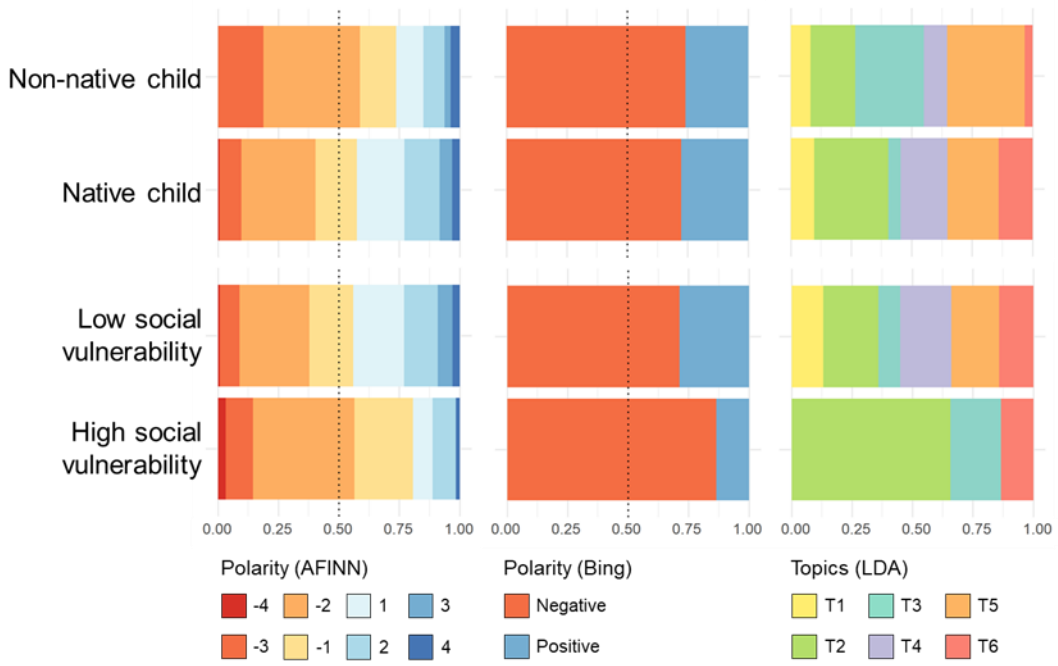

Figure 25: Polarity of terms and distribution of topics, stratified by the nationality of children and the levels of social vulnerability.

In order to illustrate the effect of all variables collected on the children's statements in a rigorous and non-exhaustive manner, statistical tests for difference of means are applied to both AFINN and Bing lexicons, once the terms are reassembled in the segments of text.

Aligned with the graphs presented, the sentiment analysis stratified by transport mode shows different results according to the lexicon adopted. Indeed, the BING lexicon demonstrates more negative comments associated with the motorized modes (car and motorcycle), while the AFINN lexicon does not seem to identify significant differences between the two groups, as indicated in Table 21.

For the other variables in the questionnaire to caregivers, the differences seem to be aligned independently of the adopted lexicon, albeit with different levels of statistical significance. In a general way, non-native children, in particular boys from older parents, who live far from school and in areas of high social vulnerability are the ones who seem to emit the most negative comments about urban mobility during the activities. This seems to be in line with previous studies involving active commuting to school, which are further debated in section *5.4. Discussion*.

Table 21: Comparison of means of polarity of segments of text (AFINN: N = 1,273, Bing: N = 1,328) between relevant groups.

Variable	Mean of polarity (AFINN lexicon)	Mean of polarity (Bing lexicon)
Transport mode to school (active / motorized) [a]	-0.464 / -0.400	-0.564 / -0.662 *
Gender of child (feminine / masculine)	-0.139 / -0.598 ***	-0.506 / -0.588 *
Nationality of child (native / non-native)	-0.382 / -1.231 ***	-0.564 / -0.641
Nationality of caregiver (native / non-native)	-0.294 / -0.756 ***	-0.546 / -0.615
Age of caregiver (younger / older) [b]	-0.379 / -1.048 ***	-0.566 / -0.875 ***
Home-school distance (close / far) [c]	-0.333 / -0.495	-0.527 / -0.634 **
Level of social vulnerability (low / high)	-0.305 / -1.442 ***	-0.540 / -0.878 ***

*, ** and *** indicate statistical significance of T-test for difference of means at the 20%, 10%, and 5% level, respectively. Equal variances are not assumed. [a] Active: walking or bicycle: motorized: car or motorcycle. [b] Younger: below 50 years old; older: 50 years and older. [c] Close: shortest-path distance between home and school below 1,000m; far: greater or equal than 1,000m.

5.4. Discussion

5.4.1. Inquiry approaches with young children

Through the Philosophy with Children inquiry approach (PwC), it was possible to bring out the voices of 5- and 6-year-old children about the transportation modes and the sentiments related to the use of street and public spaces. Starting from questions like "What scares you on the street?" and "What can/cannot be done on the street?", open and non-directed discussions were carried out seeking to arouse in-depth opinions that are normally not extracted with ease from such young children through the methods traditionally adopted in travel behavior research.

This is somewhat resonant with emerging research on the inclusion of children's voices in transport planning, where Westman et al. (2020) indicate that "younger children should receive more focused and open-ended questions" and that "the type of question asked affects the number, accuracy, and organization of children's responses". The open and somewhat unpredictable character of philosophical inquiry with children serves to elicit deeper aspects about transport that are not apparent from an adult perspective in a first instance. The

philosophical inquiry may also provide the "conditions for an experience of thought to actually occur with authenticity" (Gomes, 2019), which engages children in the PwC sessions and is particularly critical in crowded classrooms of most public schools in Global South countries. The importance of broad open-ended prompts with children is similarly highlighted by Brown and Lamb (2015), as they "encourage children to elaborate on previously reported information" and are associated with "greater accuracy, more forensically important information, and fewer inconsistencies than close-ended questions".

By basically focusing on the gathering of collective questions and inquiries (initial setting) and the promotion of the relationship between the participants, the PwC approach nurtures the collaboration *amongst the children*, where the central role of participating adults (researchers and class teachers) is to propose an initial question, preserve the conditions to philosophize (sitting in a circle and asking for the floor to speak), and empower children to call on one another. Children's empowerment is also pointed out as being crucial in transport research with children, since children tend to report a broader range of issues not mentioned by parents (Crawford et al., 2017) and the interviews conducted in the presence of parents are prone to social bias and desirability (Noonan et al., 2016).

Through the Philosophy with Children inquiry approach, it is assumed that by philosophizing one learns to dialogue and, therefore, philosophizing is speaking and listening (Olarieta and Kohan, 2014). Through philosophical dialogue with children, an encounter with the narratives of childhood was sought in order to collectively compose the perceptions about the places where children play, live and move around. The "construction of safe places for dialogue" in the PwC inquiry approach is sought through "the equal capability to think at all stages of life, based on the themes that are elaborated/generated with the children and on the provision of conditions for everyone to speak and listen" (Barreiros et al., 2019a, p. 182).

The implementation of the inquiry sessions revealed therefore a great potential of the Philosophy with Children to enquire children about their established travel behavior and to extract relevant information about the views and perceptions of daily mobility from the point of view of children. Beyond covering an age group that is commonly disregarded in most of transport-related studies involving children and youth, the proposed PwC sessions were able to encompass a context of children in public schools in a Global South country, many of them coming from low-income communities with a high prevalence of immigrant families. Moreover, this method also seems to be more inclusive than those most commonly found in the transport literature, since it is carried out in a context where children and adult participants seek to position themselves in a position of equality in both speech and listening, where children can contrast their opinions with those placed by their peers collectively, which has become rare in the traditional school environment. No similar study has been found in the literature to date.

5.4.2. Text mining in travel behavior research with young children

Besides being aligned to the discussions proposed in the PwC sessions, the topic model obtained (K = 6 topics) considered some relevant subjects about urban mobility from the point of view of children, which seem to be consistent with previously published research, mostly adopting the coding of segments of text through thematic analysis using focus groups, photo-voice, and questionnaires. The topics related to fears (both indoors and on the street) are the most widely reported in the literature, which corresponds to 38% of children's statements (Topics 5 and 6). This predominance of fear and danger during the PwC sessions is commonly raised by children as a challenge (Hinckson, 2016), which seems to reflect the perception of most parents to be "better safe than sorry" (Crawford et al., 2017) and of teachers and school staff, whose communications and policies often perpetuate "the notion that children are at risk outside the school grounds" (*Ibid.*). Conversely, perceptions about enjoyment and play (Topics 3 and 4) are also frequently reported in the children's statements (28%). These statements might be related to the "opportunity to be with friends, play games, talk about things" (Hinckson, 2016) and to the "natural elements, recreational amenities and retail spaces" (Romero, 2015), which are typically associated to walking in the literature and to the extended family members (grandparents, aunts, uncles, neighbors, *etc.*). The perceptions of both fear and pleasure seem to be best perceived by children using collective modes of transport (e.g. school buses and public transport), which seems to reveal the potential of such transport modes, even if motorized, to promote experiences of joy and conviviality that are not perceived by children using other motorized modes such as the private car, which seem to disregard relevant issues of their daily urban mobility.

In sentiment analysis, the AFINN and Bing lexicons provided results in the same direction for most of the variables tested. Boys presented more negative statements when compared to girls, corroborating the reported differences in the perceptions of the physical environment related to gender of children (Page et al., 2010). The group of girls obtained the greatest average polarity among all stratified analyses, which may resonate with the gender bias found in the association of neighborhood walkability with children's independent mobility, where only girls seem to be affected by the walking environment conditions (Villanueva et al., 2012).

Being a non-native child seems to negatively affect children's views about urban mobility, although this is only identified using the AFINN lexicon. However, living under high social vulnerability has a significant impact on the polarity of statements during PwC sessions, resulting in the lowest polarities amongst all comparisons made. The lower polarities found among low-income and non-native children seem to bring to light dimensions of precariousness that go beyond the effect of the phenomena traditionally attributed to transportation, which

even arrives in discussions about the places and experiences on the street using the philosophical inquiry approach. This seems to be aligned with the "struggle to find a place for an activity" identified among second-generation immigrant children by den Besten (2010).

A similar pattern seems to apply to the caregivers, where both nationality and age range appears to play a role. As with the children, being a non-native caregiver seems to have a significant negative influence only when using the AFINN lexicon, while having older parents seems to greatly influence the opinions expressed by children in the PwC sessions in a negative way. In fact, the influence of parents on younger children is remarkable, especially concerning the restrictions to use other transport modes (Mitchell et al., 2007) and the importance of parents' concerns in the perception of threats posed by strangers (Crawford et al., 2017), which seems evident in the children of this study as well. However, an additional aspect of this study is related to the negative influence of non-native parents, which is consistent with the increased concern about children's mobility found among recent immigrants, who "tended to restrict children's level of independent mobility" (*Ibid.*).

With regard to the variables directly related to urban mobility, the most significant differences were found using the BING lexicon. Closer home-school distances are associated with less negative segments of text shared by children during the PwC sessions, which seems meaningful given the influence of short trips on a greater cohesion and social control in active travel to school (Waygood and Friman, 2015). On the other hand, the means of polarity by mode of transport (active vs. passive) were the only analyses presenting different results depending on the lexicon used. Nonetheless, the BING lexicon stands alone in presenting statistically significant differences, with a lower polarity found among children using motorized modes to go to school (car or motorcycle). That is convergent with the writing activities conducted by Mitchell et al. (2007), where the majority of children "expressed a desire to use an active mode of transport".

Despite stemming from unsupervised algorithms, both topic modelling and sentiment analysis require the active participation of researchers in the PwC sessions (together with the children and class teachers) and in the application of questionnaires (with caregivers and school staff), since the labelling of topics, filtering of the appropriate PwC sessions, and the identification of relevant groups for stratification (*e.g.* nationality of children and age of caregivers) are underpinned by the analyst's familiarity with i) the contents of the PwC sessions; ii) the characteristics of the children that seem to elicit their participation in the PwC sessions; and iii) the specific features of the participating schools, both to manage the sessions in their weekly routines and to collect data with caregivers.

The influence of variables within and outside the transport field on the opinions on urban mobility shared by such young children is remarkable. From early childhood on, there seems to be a cyclical effect that affects boys – more negative about urban mobility – to be less likely to adopt active modes of transport as male adults. This does not seem to be restricted to the issue of gender, since smaller polarities in the PwC sessions about urban mobility are also associated with non-native children and those in high social vulnerability, which present a greater share of active travel to school when compared to native children in low social vulnerability. With the exception of the child's gender, that seems convergent with the findings by Babey et al. (2009) on the bias in the adoption of active travel to school by "males, Latinos, from lower-income families, attending public school, living in urban areas, and living closer to school".

In a not very long time frame, 15 years at most, these children may become adults whose opinions are unlikely to be subject to major changes, which is reinforced by the failure to prioritize sustainable transport policies in low-income communities. Consequently, there is a rather negative symbolic burden on the modes of transport that are usually available to poor households (generally active mobility and collective transport for those who can afford it), which is reflected by five-year-old children.

6. Effects of school-based interventions on the travel behavior of children and caregivers

As indicated in the *Introduction* of this thesis, home-school trips made by children and youth represent a significant share of daily trips in several parts of the world. At the same time, many countries have registered a decline in children's active and independent mobility, which is undesirable for building safe, sustainable, and inclusive cities (Fyhri et al., 2011a). In this sense, schools can have a major role in promoting sustainable habits, including the right to live in sustainable cities, to use clean transport modes and to have good access to relevant destinations. This section seeks to explore the mechanisms underlying changes in the travel behavior of young children and their caregivers due a set of school-based interventions.

Previous research articles have identified the impact of interventions on children's physical activity and active commuting to school, although it has tended to disregard younger children and the case of low-income communities, especially in the Global South. Furthermore, there is still much to be researched on the interaction between people's perceptions and the reported travel behavior, mainly related to participatory approaches to incorporating children's voices and the impact assessment of child-centered interventions on adults. Finally, there is a limited number of studies evaluating the interplay between different types of interventions, including the differential impact of outdoor and in-classroom interventions on the effectiveness of such programs.

To address this research gap, this section seeks to evaluate the changes in travel behavior following the implementation of a 4-month school-based program focused on: i) exploring the open public space in the surroundings of schools through walking and ii) inquiring children about urban mobility through the "Philosophy with Children" (PwC) participatory approach.

Henceforward, this section provides a more detailed description of the sources of data, methods for analyzing data, and the adopted strategies to promote changes in travel behavior, in section *6.2. Methods*. Subsequently, in section *6.3. Results* the observed changes in the travel behavior of children and their caregivers are presented, whose discussion is carried out in section *6.4. Discussion*. A graphical abstract related to this section is provided in Figure 26, as follows.

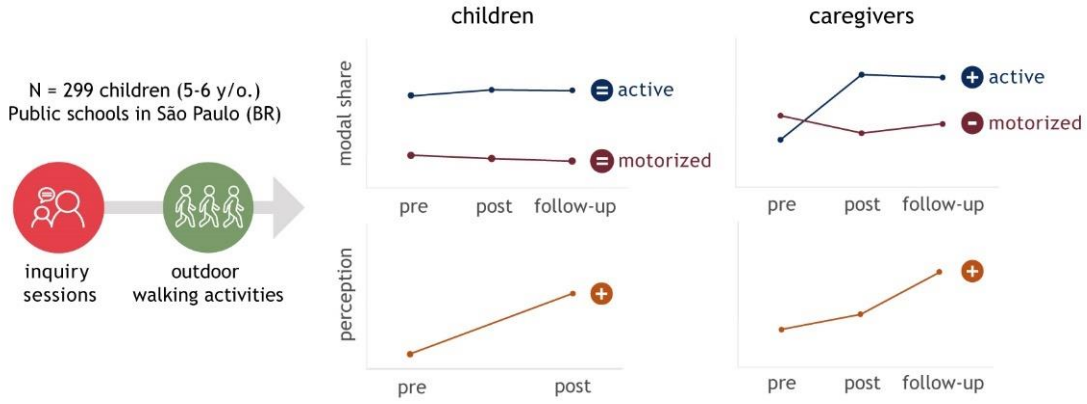

Figure 26: Graphical abstract of the manuscript "Assessing the impact of discussing and practicing urban mobility on the travel behavior of young children and their caregivers" (Humberto et al., 2021).

An earlier version of the work presented in this chapter has been published in the Journal of Transport Geography in January 2021 (*cf.* Humberto et al., 2021).

This section is associated to key research question number 3 (K-RQ3) and its respective specific objectives (S-O4 and S-O5) and specific research questions (S-Q11 to S-Q15). See Table 1, Table 2, and Table 3 (section *1.1. Objectives and research questions*) for further details on the association of key research questions (K-RQ) with the specific objectives (S-O) and specific research questions (S-RQ) of this doctoral research.

6.1. Highlights

- Effectiveness of child-centered interventions on the travel behavior of caregivers;
- Discussing urban mobility in school impacts the perception of children and caregivers;
- Role of perceptions and early childhood on behavioral changes towards sustainability;
- Relevance of the child-caregiver relationship in travel behavior research;
- Early findings on the cycle of behavior change given the child-caregiver relationship.

6.2. Methods

Two intervention types (inquiry sessions and outdoor walking activities) were implemented as part of a 4-month program in three public preschools within the Municipality of São Paulo (Brazil), between March and June 2019. The Municipality of São Paulo (also referred to as City of São Paulo) is one of the municipalities that compose Metropolitan São Paulo, which covers a surface of 7 947 km^2 and 21.6 million inhabitants distributed in 39 municipalities. The City of São Paulo itself accounted for 1 521 km^2 and 12.1 million inhabitants in 2018 (Emplasa, 2019; Estado de São Paulo, 2011). Being acknowledged for its "growing social and economic inequalities (...) embedded through high spatial inequality" (Moreno-Monroy et al., 2018, p. 110), the context of Metropolitan São Paulo may also contribute to the development of the yet under-studied research agenda on the Global South concerning the travel behavior of children and their caregivers. In this study, only public preschools were considered as prospective sites for data collection and analysis. Furthermore, in the search for schools representative of the transport conditions encountered by preschoolers in São Paulo, the schools analyzed in this research were selected according to the "levels of mobility resources" as defined through the Capability Approach, indicating comparable “conditions to walk provided for the children and their caregivers” (Humberto et al., 2020b).

Baseline measures were collected with caregivers before the interventions (T1), after the interventions (T2) and in a two-month follow-up (T3). Data provided by children (aged 5-6 y/o.) consist of the sentiment orientation (positive to negative) of the children’s statements during the inquiry sessions as obtained using sentiment analysis (Humberto et al., 2020a).

The gathered data were analyzed by comparing the measures delivered by children and their caregivers through a set of statistical tests, including time-series analysis (pre-post and pre-follow-up), difference-in-differences (accounting for time-series and differences due to the combination of strategies), and the stratification in relevant groups (gender, nationality, and level of social vulnerability). During the six-month period analyzed, no marked changes were observed regarding public security and transport conditions, including facilities for pedestrians, cyclists and public transport users. The description and context of children and caregivers involved in this study are presented in section *6.3. Results*.

6.2.1. Intervention types

The intervention types analyzed in this manuscript stem largely from a joint research project among the University of São Paulo, the University of Lisbon and the non-government organization *apē estudos em mobilidade* (apemobilidade.org), which sought to assess the impact of both discussing and practicing active mobility in the school setting on the travel behavior of young children and their caregivers. To achieve this, a set of inquiry sessions about urban mobility (indoor) and educational activities through walking in the schools' surroundings (outdoor) was implemented together with children and staff from the participating schools.

The outdoor activities consisted of walks either to a relevant destination located around the schools (e.g. library, museum, public garden, carpet factory) or in the neighborhood itself, which were proposed in collaboration with the local NGO, whose projects seek to "arouse a permanent curiosity in young people" as an "experience of education in urban mobility" (Nogueira, 2015, para. 8). As part of an education project seeking to practice urban thinking through walking with children, the proposal is drawn throughout meetings organized for a month before the day of the activity. The route planned is discussed together with schoolteachers, in which the themes to be approached are discussed, including the "senses that can be discovered by the children's curiosity through the walking experience" (Walk 21 Vienna, 2015, para. 3). At the day of the outdoor activity, the children are oriented by a map of the walking route, which proposes "stops in interesting points, such as big trees, squares and colorful paintings on the walls". (Walk 21 Vienna, 2015, para. 5). By stimulating the imagination and attention of children "through the senses and questions about the urban space, the project aims to present children and teachers as responsible commuters of the public spaces they walk and to make the experience outside school something comfortable and familiar" (Walk 21 Vienna, 2015, para. 5). These educational activities lasted approximately one hour and were applied every two months to 29% of the surveyed sample (N = 87 children from three classes).

As explored in previous parts of this thesis (sections 3.5.1.1 and 3.6.1), the inquiry sessions were built on the concepts of the Philosophy with Children (PwC) approach, which "thinks of philosophy not as knowledge or content but as a relationship with knowledge and thought" (Kohan, 2015, p. 156). The PwC approach focuses on "creating the conditions to philosophize", which means that everyone sits in a circle, asks for the floor to speak and promotes the relationship between the participants of the inquiry sessions (Kohan, 2015, pp. 156–157). According to Gomes (2019), the "experiences of thinking" proposed by the PwC practices promote the "possibility to change" by affirming students' and teachers' different voices and following some methodological steps, including the gathering of collective inquiries and the identification of relevant themes and questions for further discussion (Gomes, 2019, p. 34). In

this study, a series of eleven PwC sessions was carried out to address different dimensions of urban mobility from the children's point of view, whose detailed description is provided in Table 12 (section 3.5.1.1). The inquiry sessions were applied weekly to the entire sample (N = 299 children from nine classes).

6.2.2. Data sources

As previously introduced in section 3.5.1, questionnaires were completed by the caregivers in three stages: i) two weeks before the beginning of the PwC sessions (T1: pre); ii) at the end of the inquiry sessions and outdoor activities (T2: post, four months after T1); and iii) after winter school break (T3: follow-up, six months after T1), covering a set of socio-demographic variables, the adopted transport modes by children and caregivers, and descriptive social norms towards active mobility as informed by the caregivers. A more detailed description of the variables collected in the questionnaires is provided in Table 22.

In the case of data collected with children, the transcription of the inquiry sessions originally yielded a text corpus with 27,943 segments of text. The comments of the participants during the PwC sessions (before and after the first outdoor walking activity, T1 and T2) encompasses both children and adults (school staff and participating researchers) and can vary from short comments to long contributions to the discussions at stake. Approximately one third (28%) of such segments were associated to children whose caregivers answered the questionnaires, and 7% of them (N=1,909) could be joined to the AFINN sentiment lexicon, which estimates the polarity of pieces of text by classifying terms in integer values between -5 and -1 for negative words and between 1 and 5 for positive words, with a predetermined prevalence (65%) of negative terms (Nielsen, 2015). This includes polarity values for children's statements between -3.000 and 4.000 once terms are reassembled in the corresponding segments and divided by the segment of text's word count. In this sense, positive (or less negative) polarity values indicate children's statements with rather positive sentiments, and vice-versa. A detailed description of the sentiment analysis used in this study is provided in section 5.2.2 previously presented.

In order to supplement the data provided by caregivers (questionnaires) and children (transcripts of inquiry sessions), information about the nationality of children and their caregivers was obtained using school documents as provided by school staff. The description of these variables is also presented in Table 22 (below), which is complimentary to Table 13 previously presented in section 3.5.1.2.

Table 22: Type, description and sources of data of variables collected (caregivers, children, and school staff).

Source of data	Variable	Description	Type	Stage of study
Quest. to caregivers	Transport mode (caregiver)	Which transport mode(s) do you (caregiver) commonly use during the week? 1) Walking; 2) Car; 3) City bus; 4) Bicycle; 5) Subway; 6) Suburban train; 7) Motorcycle; 8) Other.	Nominal. Multiple response question. 8 options available	T1, T2, T3
	Transport mode (child)	Which transport mode(s) does your child commonly use to go to school? 1) Walking; 2) Public school bus; 3) Private school bus; 4) Car; 5) City bus; 6) Bicycle; 7) Subway; 8) Suburban train; 9) Motorcycle; 10) Other.	Nominal. Multiple response question. 10 options available	T1, T2, T3
	Descriptive social norms	In your opinion, children generally walk to school: 1) Never; 2) A few times; 3) Many times; 4) Always.	Ordinal. Integer values between 1 and 4	T1, T2, T3
	Age of caregiver	What's your age (caregiver)?	Integer	T1
	Household size	How many people live in your house?	Integer	T1
	Location of residence	Home address	Text	T1
Inquiry sessions	Polarity of statement	Polarity of children's statements during the inquiry sessions (AFINN sentiment lexicon).	Continuous	T1, T2
School staff	Gender of child	1) Girls; 2) Boys	Nominal. 2 options available	T1
	Nationality of child	1) Native; 2) Non-native	Nominal. 2 options available	T1

The data on transport mode use (children and caregivers, as reported by caregivers) were subsequently processed to represent the adoption of active transport modes (walking or cycling) and motorized transport modes (car or motorcycle) as a nominal variable, for instance adoption of active transport (1) and non-adoption of active transport (0). As they are derived from multiple response questions, these variables are not mutually exclusive and therefore cannot be combined. The nationality of the children surveyed originally contains ten different nationalities, but for the sake of simplicity only native and non-native children are presented as alternatives in Table 22. Finally, the georeferencing of the children's households as provided by the caregivers enabled the association with public datasets about the housing conditions, including the determination of low, moderate and high levels of social vulnerability (SEADE, 2012).

As previously indicated in section 3.5.3, the data collection and processing were approved by the Research Ethics Committee of the Institute of Psychology at the University of São Paulo (CEPH-IPUSP) on December 2018. The doctoral candidate was part of the group of four

researchers that coordinated the data collection and the implementation of the intervention types (inquiry sessions and outdoor walking activities) in the analyzed schools.

The methodology adopted is summarized schematically in Figure 27 (below), which is complimentary to Figure 7 previously presented in section 3.6.

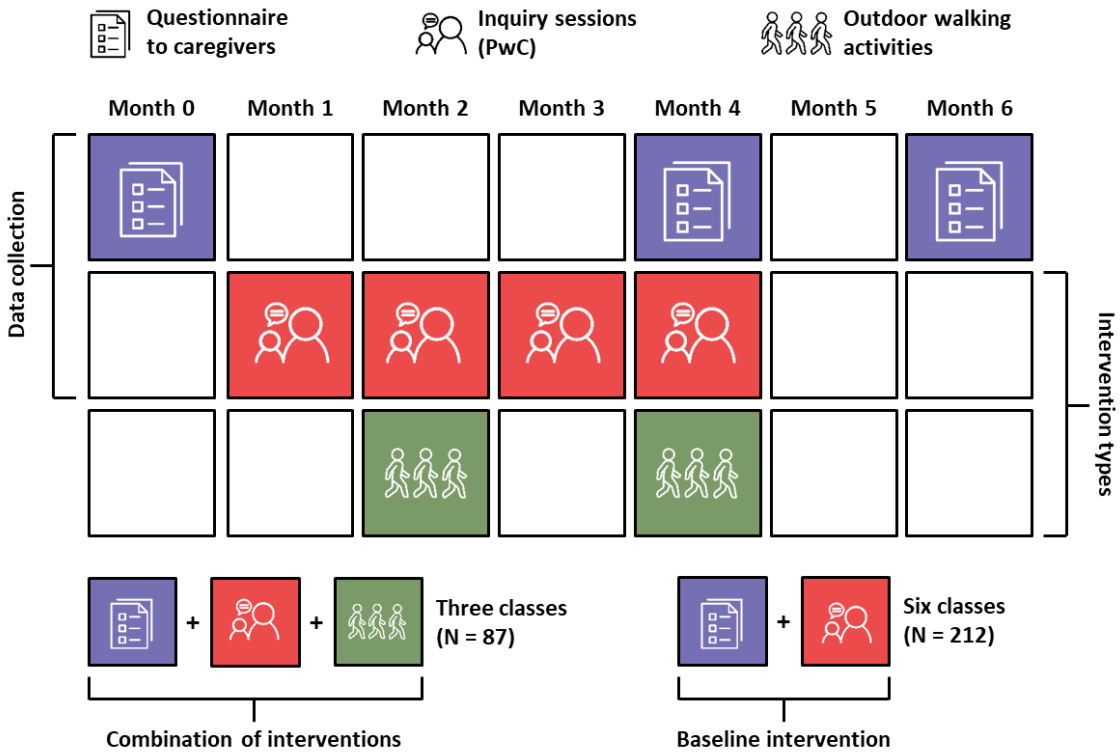

Figure 27: Schematic representation of the adopted methodological steps (intervention types and sources of data).

6.2.3. Data analysis

To handle the data from the questionnaires and inquiry sessions, two analytical approaches for comparing the collected measures were implemented: time-series analysis and difference-in-differences. While both methods stem from quantitative methods commonly used in economic and health assessments for the estimation of policy effects, a difference-in-differences analysis "compares the change in outcome for an exposed group between a moment before and a moment after the implementation of a policy to the change in outcome over the same time period for a non-exposed group" (Hu et al., 2017, p. 4). Similarly, a time-series analysis (also known as interrupted time-series) compare the outcomes before and after policy

implementation and differs from a difference-in-differences analysis by not requiring a separate control group (*Ibid.*).

In this study, the time-series analysis accounts for the differences in the observed variables between the stages of the study (pre, post, and follow-up, i.e., T1, T2, and T3), whereas the difference-in-differences analysis regards the differences in the consecutive observations (T1, T2, and T3) between the group of children exposed either to the baseline intervention (inquiry sessions, I1) or a combination of interventions (inquiry sessions + outdoor walking activities, I2).

In both approaches, the time is incorporated in the regression models by examining the collected measures before the interventions (T1) and in the following stages, *i.e.*, pre-post (T1-T2) and pre-follow-up (T1-T3). In the regression models, this is represented by defining the variable *Stage*, as follows.

Pre to post: $Stage = \begin{cases} 0\ for\ \text{T1}; \\ 1\ for\ \text{T2}; \\ null\ for\ \text{T3}. \end{cases}$ Pre to follow-up: $Stage = \begin{cases} 0\ for\ \text{T1}; \\ null\ for\ \text{T2}; \\ 1\ for\ \text{T3}. \end{cases}$

Similarly, the consideration of the intervention types is done by comparing groups of children participating in both intervention types (I2) or in inquiry sessions only (I1) by means of variable *Group*, for both pre-post and pre-follow-up analysis, as follows.

$$Group = \begin{cases} 0\ for\ I1\ \text{(baseline intervention)}; \\ 1\ for\ I2\ \text{(combination of interventions)}. \end{cases}$$

In this sense, differential effect of outdoor walking activities on travel behavior, as compared to the baseline intervention (I2 *vs.* I1), can be expressed by the variable *StageGroup*, defined as follows.

$$StageGroup = Stage * Group$$

Accordingly, the interest coefficient for time-series analysis is the one related to the variable Stage, whereas in difference-in-differences analysis the interest coefficient is related to the variable *StageGroup*, both indicated as β_3 in Figure 2. In the results and discussion presented in the following sections, both coefficient and statistical significance (p-value) are observed to evaluate the changes in travel behavior of children and their caregivers due to the interventions implemented, which are further stratified by the most sampled groups of gender, nationality and level of social vulnerability according to questionnaires and statements during the inquiry sessions. A schematic representation of these analytical approaches can be found in Figure 28.

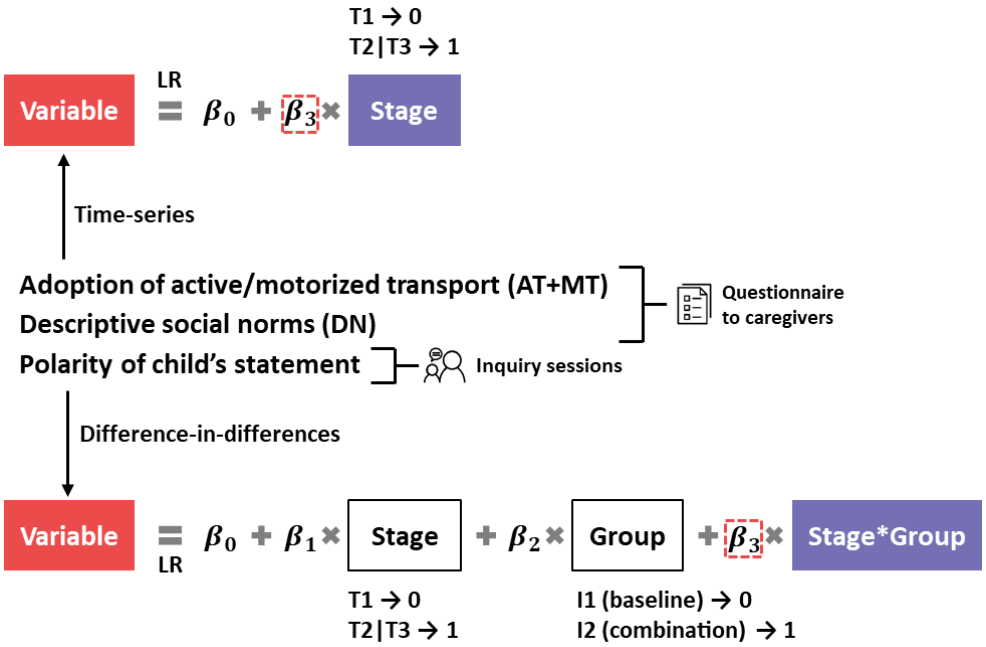

Figure 28: Schematic representation of the adopted analytical approaches (time-series and difference-in-differences). The interest coefficient for assessing the impact of interventions is highlighted (β_3). LR: Linear Regression model; AT: active transport (walking or cycling); MT: motorized transport (car or motorcycle).

6.3. Results

The assessment of the proposed interventions is based on the abovementioned empirical research project implemented in three public preschools in the city of São Paulo (Brazil). Despite being located within a region known as the "Expanded Center" (*Centro Expandido*) that concentrates most of the jobs and public facilities in the municipality (health, education, transport, culture, *etc.*), the surroundings of the analyzed schools are characterized by poor housing conditions and the concentration of low-income immigrants working in the clothing and textile sector, predominantly from Bolivia (Pucci, 2013).

The location of the analyzed schools and children's households can be found in Figure 29, which indicates a context with a high share of active travel by younger children to and from school, coupled with a situation of precarious housing in the regions where most of children and caregivers surveyed live. The lower shares of active trips in the other zones within the Expanded Center are noticeable, which seems to point out to spatial inequalities related to children's mobility that are found in the interplay of the analyzed region with its surroundings, where better transport services and employment opportunities overlap with the spread of slums and

squatter settlements in low-income communities (see Figure 30, Figure 31 and Figure 32 below). Similarly, a more detailed contextualization of schools and the location of children's households is provided as supplementary materials (*Appendix A: Supplementary materials*): the location of other public preschools (Figure 36), the share of motorized school trips of preschoolers and primary school-aged children (Figure 37), and the share of active and motorized trips of their caregivers (Figure 38 and Figure 39). The descriptive statistics of the collected data can be found in Table 23.

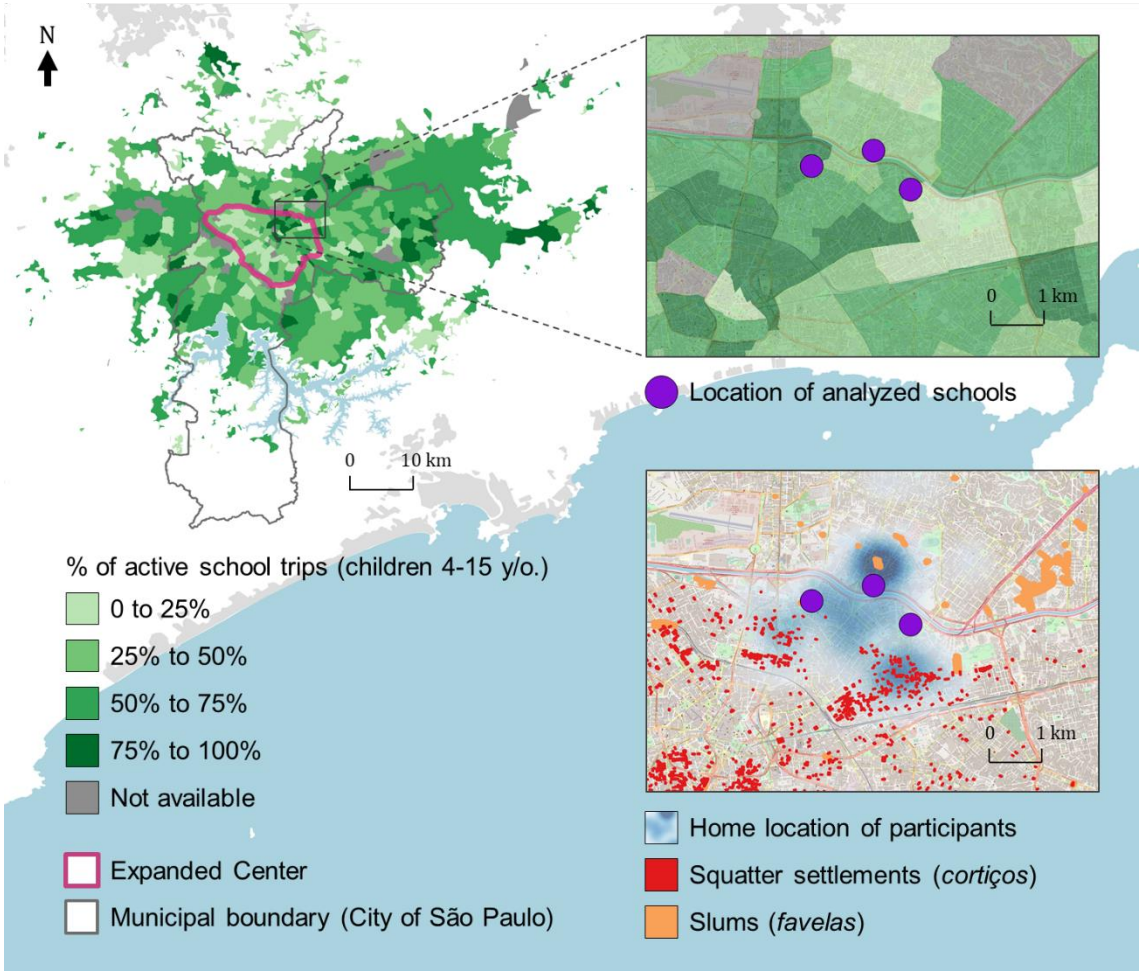

Figure 29: Context of analyzed schools in Metropolitan São Paulo regarding the share of active school trips (walking or bicycle) of preschoolers and primary school-aged children (aged 4-15 y/o.) and association of participating children's households with the presence of slums and squatter settlements. Both public and private schools were considered. Adapted from CET (2013), GeoSampa (2018), HabitaSampa (2019), IBGE (2005), and METRÔ-SP (2018).

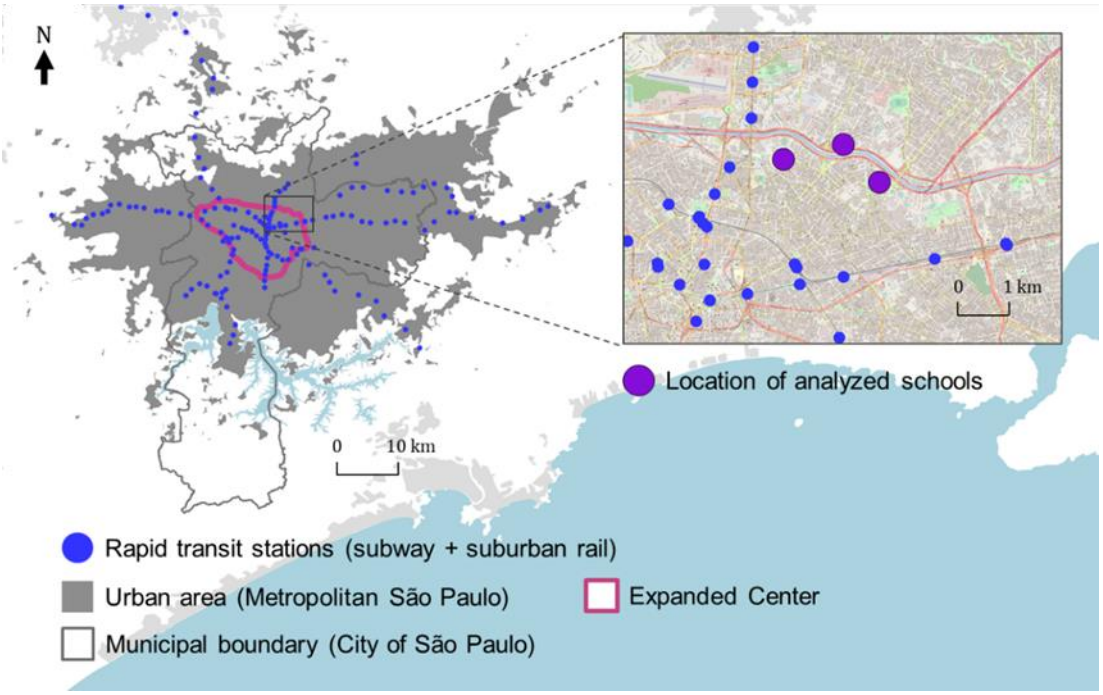

Figure 30: Context of analyzed schools in Metropolitan São Paulo regarding the location of rapid transit stations (subway and metropolitan suburban rail). Adapted from CET (2013), GeoSampa (2018), and IBGE (2005).

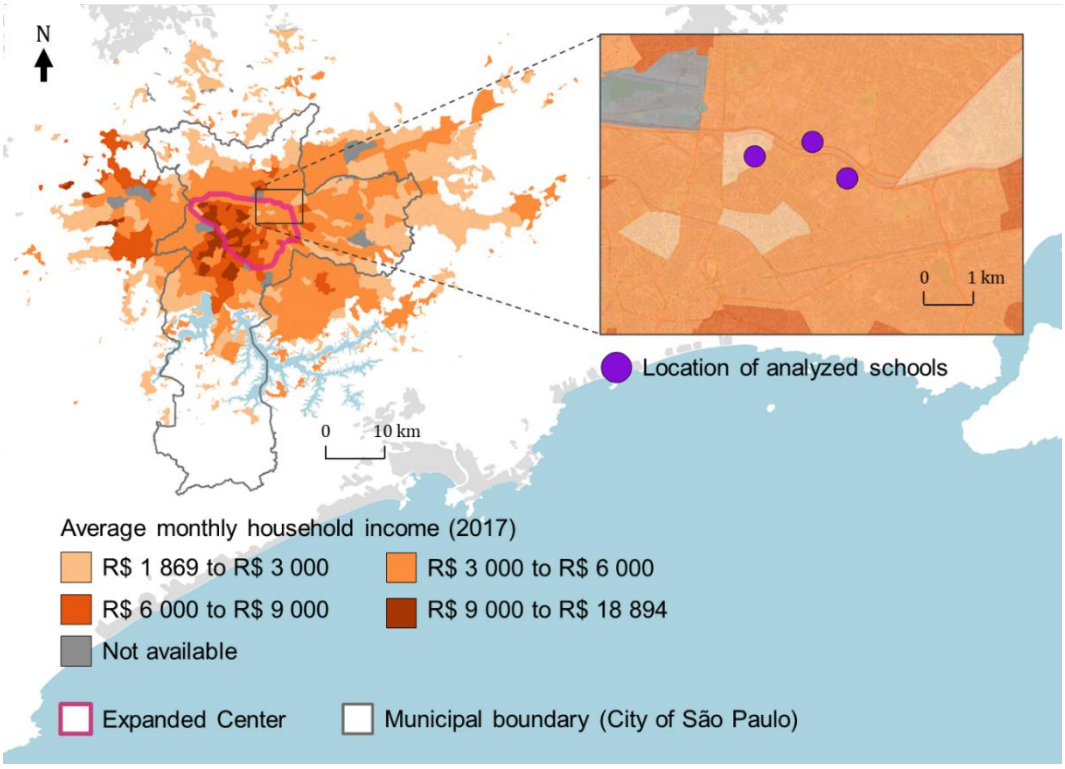

Figure 31: Context of analyzed schools in Metropolitan São Paulo regarding the average monthly household income (in R$/month). Adapted from CET (2013), GeoSampa (2018), IBGE (2005), and METRÔ-SP (2018).

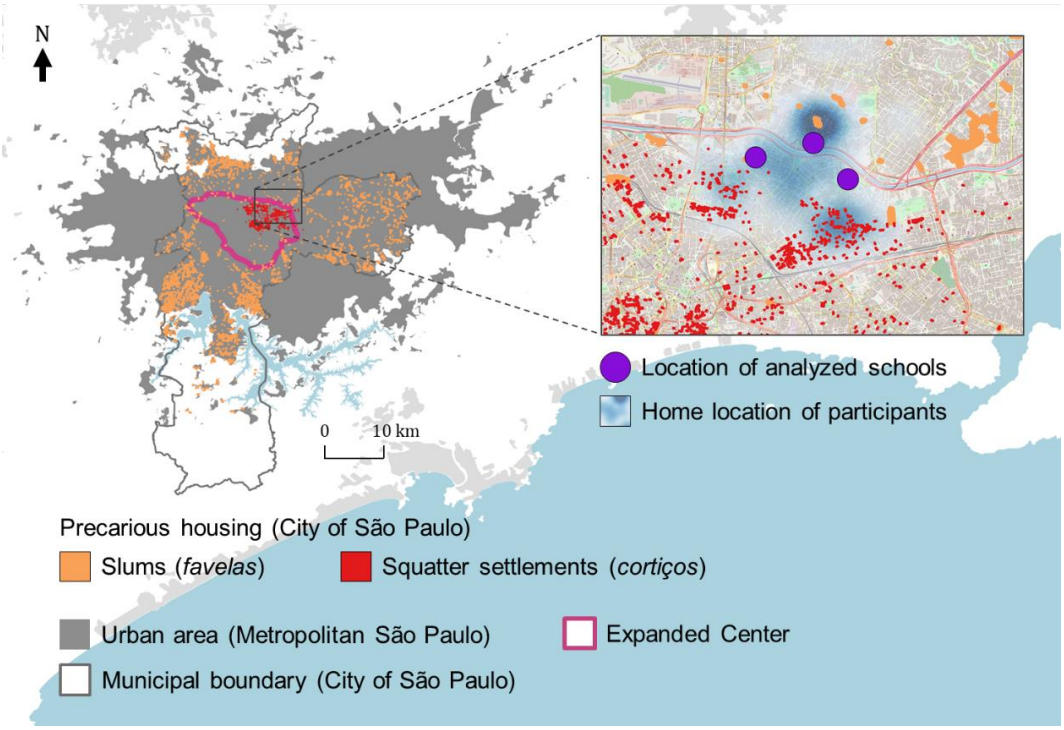

Figure 32: Context of analyzed schools in Metropolitan São Paulo regarding the location of slums and squatter settlements in the Municipality of São Paulo. Adapted from CET (2013), GeoSampa (2018), HabitaSampa (2019), and IBGE (2005).

Table 23: Descriptive statistics of collected data (Impact of school-based strategies on travel behavior change) in three phases of the research project: before (T1) and after (T2) the implementation of intervention types, and on follow-up measures (T3).

Source of data	Measure	T1 (pre)	T2 (post)	T3 (follow-up)
Quest. to caregivers	% AT (caregivers)	28	73	72
	% MT (caregivers)	47	34	39
	% AT (children)	61	64	64
	% MT (children)	22	20	18
	Descriptive social norms	1.9 (0.9); 1 < 2 < 3; Min: 1; Max: 4	2.2 (1.0); 1 < 2 < 3 Min: 1; Max: 4	3.0 (0.7); 3 < 3 < 4 Min: 1; Max: 4
	Age of caregivers	33.4 (8.9); 26 < 32 < 38; Min: 15; Max: 72	-	-
	Household size	5(2.6); 3<4<6; Min: 2; Max: 18	-	-
	% in low social vuln.	87	-	-
	Response rate	78	65	53
Inquiry sessions	Polarity of statements (x100)	-10 (63); -40 < -14 < 20; Min: -300; Max: 400	9 (54); -20 < 8 < 33 Min: -150; Max: 400	-
School staff	% of boys	53	-	-
	% of natives	75	-	-

AT: Active Transport (walking or cycling); MT: Motorized Transport (car or motorcycle). Standard notation for non-categorical variables: Mean (SD); 1st quartile < Median < 3rd quartile; Min: Minimum value; Max: Maximum Value.

The children surveyed seem to present a share of active school commuting above the city's average, mainly girls, non-native children and those living under high social vulnerability, as presented in Table 24. On the other hand, the percentage of motorized school travel (car or motorcycle) is also above the city's average in the households analyzed, which may indicate a lower adoption of other transport modes, such as the school bus, railway and the city bus to access schools, notwithstanding the greater availability of public transport facilities in the region in relation to Metropolitan São Paulo as a whole (*cf.* Figure 30 in Appendix A: Supplementary materials). In contrast, the children's caregivers present lower share of active trips and higher share of motorized trips when compared to the whole municipality. The children affected by both intervention types (I2) have a more active modal share in accessing schools and seem to be less vulnerable than the other children, which can be related to the profile of caregivers who allow children to attend outdoor activities with no parental participation.

Regarding the participation in the inquiry sessions, represented by the amount and the polarity of statements during the PwC sessions, the prevalence of native and least vulnerable children is remarkable, even when considering the larger sample size of these groups. Moreover, girls and children under low social vulnerability present the most positive polarities among other groups. On the other hand, the negativity of the statements made by non-native and more vulnerable children is also outstanding.

Table 24: Stratification of statistics of selected measures according to relevant groups (gender, nationality of children, level of social vulnerability, and inclusion in intervention types) and comparison with the municipality of São Paulo.

Source of data	Measure	All children	Boys/Girls	Native/ Non-native	Low/high social vuln.	I1 / I2	São Paulo [c]
Questionnaire to caregivers	Sample size (N)	232	117 / 115	118 / 44	155 / 24	212 / 87	-
	% AT (caregivers) [b]	28	29 / 27	29 / 23	29 / 27	29 / 25	38 [c]
	% MT (caregivers) [b]	47	46 / 48	46 / 50	50 / 32	44 / 52	32 [c]
	% AT (children) [a]	61	57 / 64	59 / 68	61/ 73	54/ 75	45 [c]
	% MT (children) [a]	22	20 / 24	24 / 11	19 / 18	24 / 17	12 [c]
	% AT (caregivers) [b]	28	29 / 27	29 / 23	29 / 27	29 / 25	38 [c]
	Average descriptive social norms	1.92	1.90 / 1.95	1.94 / 1.84	1.92 / 2.10	1.95 / 1.80	-
	% in low social vulnerability	87	85 / 89	84 / 96	-	81 / 94	56 [d]
Inquiry sessions	Number of statements (N)	1909	766 / 562	1154/ 174	847 / 61	870 / 405	-
	Average polarity of statements (x100)	-8.0	-6.7 / -2.5	-4.3 / -9.4	-2.7 / -28.0	-4.9 / -6.7	-
School staff	% of boys	53	-	51 / 59	50 / 58	53 / 54	51 [c]
	% of natives	75	72 / 78	-	72 / 92	82 / 61	-

AT: Active Transport (walking or cycling); MT: Motorized Transport (car or motorcycle); I1: Baseline intervention; I2: Combination of interventions. [a] Share of AT/MT in the usual transport modes during the week (T1); [b] Share of AT/MT to/from school (T1); [c] Includes households with children aged 5-6 y/o. attending public schools in the municipality of São Paulo, extracted from METRÔ-SP (2018); [d] Extracted from SEADE (2012).

Regarding the modal shifts throughout the implementation of the intervention types (pre, post and follow-up), no major changes can be detected in the way children access schools, as shown in Figure 33. With initial measures (T1) largely oriented towards active modes, especially in the group of children combining intervention types, changes in children's travel behavior are hardly noticeable, both for active and motorized modes of transport. On the other hand, the reported impact on caregivers towards sustainable mobility (increased adoption of active modes and decrease in motorized transportation) seems considerable, notwithstanding their indirect role in the proposed interventions: greater use of active modes and reduced adoption of motorized modes, particularly in pre-post analysis, with relatively sustained effects on follow-up measures. Both effects seem to be more pronounced among caregivers whose children attended both outdoor walking activities and inquiry sessions.

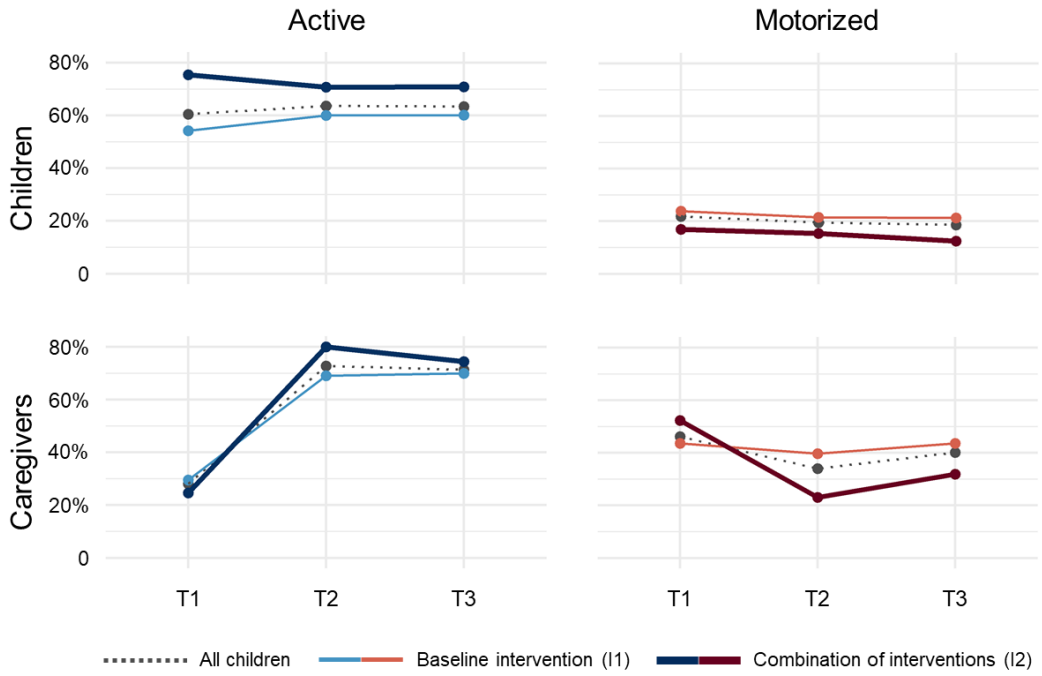

Figure 33: Modal share of trips (active and motorized) of children and their caregivers throughout the implementation of the intervention types (pre, post and follow-up).

Apart from the observed changes in the travel behavior of children and their caregivers, it was also possible to observe whether there were any variations in the perceptions that might follow or trigger behavioral changes in urban mobility (see Figure 34). The descriptive social norms were measured as a response provided by the caregivers to the statement "In your opinion, children generally walk to school", in which four options (ordinal values) were provided: Never (1); A few times (2); Many times (3); and Always (4). In this sense, greater values of these social norms (ranging from 1 to 4) may be associated with a clearer perception

by caregivers of a greater adoption of walking by children in general throughout the stages of the study (pre, post and follow-up). On the other hand, the polarity of children's statements was obtained by associating the transcripts of the inquiry sessions with a sentiment lexicon (before and after the first outdoor walking activity), in which greater values are associated with more positive statements made by children during the inquiry sessions. There was a positive impact on the social norms of caregivers in all groups, particularly considering the follow-up measures, although caregivers whose children have been involved in both intervention types (I2) seem to have had greater increases in their perceived walk share of transport to school.

This phenomenon points to early findings that seem relevant, as it seems to demonstrate an effect of the inquiry sessions (baseline intervention) not only on the direct beneficiaries (children), but especially on their caregivers, who were not directly involved in any other intervention seeking to change their behavior throughout the project. The fact of discussing urban mobility *per se* seems to have led parents to think that more children were walking to schools, although this topic was not mentioned in the inquiry sessions or in the interactions with the caregivers to complete the questionnaires. In addition, the children's active modal share to school, predominantly composed by walking, has remained constant along the stages of the project.

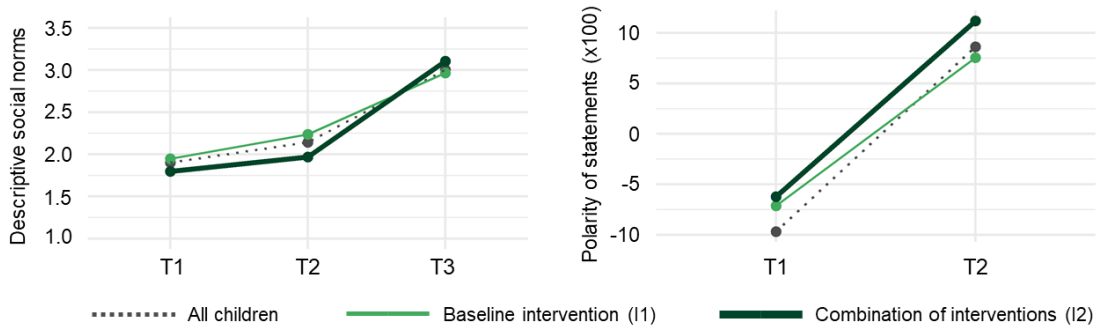

Figure 34: Changes in social norms and polarity of children's statements during the inquiry sessions throughout the implementation of the intervention types (pre, post and follow-up).

For some of the measures collected, the identification of changes due to the intervention types seems straightforward, including the unvarying modal shares among children to access schools towards both active and motorized modes. However, in addition to the observed changes throughout the project (T1 vs. T2 and T3) and between the intervention types (I1 vs. I2), it is necessary to examine the respective statistical significance in order to consolidate a careful evaluation, also considering stratified evaluations by gender, nationality and level of social vulnerability. In this sense, a set of variables related to children (polarity of children's statements during the inquiry sessions) and caregivers (share of active/motorized transport and

descriptive social norms) is examined more thoroughly in Table 25, following the analytical approaches employed: time-series analysis and difference-in-differences.

For time-series analysis, significant modal shifts towards active modes were found among caregivers in both pre-post (T1-T2) and pre-follow-up (T1-T3) tests, while for motorized modes this seems only applicable to pre-post analyses. In contrast, the increase in social norms was more significant in the follow-up measures, which may be linked to a possible triggering effect of modal shifts observed in the post-intervention period. With regard to the stratified analyses, it was not possible to detect any differential effect of the observed changes due to the child's gender, nationality or level of social vulnerability, although more pronounced modal shifts towards sustainable mobility (especially out of car and towards walking and cycling) were reported among caregivers of boys and less vulnerable children, particularly between T1 and T2.

On the other hand, analyses considering the differential effect of the intervention types over time identified fewer widespread changes. Higher modal shifts to active modes and out of motorized transport were statistically significant in the post-intervention period among caregivers of children in both intervention types (I2) as compared to those in the baseline intervention (I1). In the follow-up measurements, however, this appears to be significant only in the decrease of the motorized modal share. Caregivers of boys seem to have had a greater differential impact of outdoor walking activities on their increased adoption of active transport, both in post and follow-up measures. Amongst caregivers of native children, on the other hand, this differential impact seems to be more pronounced in decreasing their share of motorized transport only. Additionally, a positive impact on social norms was only observed among the less vulnerable households. This outlines possible indirect effects of interventions on adults, which seem to be mediated by a range of socioeconomic factors such as the child's gender and social vulnerability.

In general, more positive comments by children were noticed over time, with no marked gender, nationality or social vulnerability bias. However, once the effects of outdoor activities are taken into account, there are small positive variations in the polarity of children’s statements (especially among the less vulnerable ones), which nevertheless are not statistically significant.

Table 25: Changes in selected measures following the implementation of the intervention types (coefficient β_3 and respective P-value). * refers to the variables related to the caregivers (%AT, %MT and DN), whereas † indicates variables referring to and collected with children (polarity of children's statements). Fields whose estimates are statistically significant at the 10% level are highlighted (in gray). The results for the other measures collected are presented as supplementary material (Table SM-1).

Analysis			All children	Boys	Natives	Low vulnerability
Time-series	T1 to T2 (pre to post)	%AT*	**+44.7 (<.001)**	**+41.3 (<.001)**	**+41.8 (<.001)**	**+40.1 (<.001)**
		%MT*	**-12.1 (.012)**	**-12.5 (.067)**	**-9.8 (.073)**	**-13.6 (.041)**
		DN*	**+0.2 (.010)**	**+0.3 (.028)**	**+0.2 (.055)**	+0.1 (.394)
		Pol.†	**+18.3 (<.001)**	**+15.1 (.001)**	**+14.8 (<.001)**	**+14.0 (.001)**
	T1 to T3 (pre to follow-up)	%AT*	**+43.3 (<.001)**	**+35.1 (<.001)**	**+38.9 (<.001)**	**+35.6 (<.001)**
		%MT*	-6.0 (.245)	+0.1 (.988)	-3.0 (.609)	-7.6 (.268)
		DN*	**+1.1 (<.001)**	**+1.0 (<.001)**	**+1.1 (<.001)**	**+1.1 (<.001)**
Diff.-in differences	T1 to T2 (pre to post)	%AT*	**+15.8 (.097)**	**+24.1 (.083)**	+15.4 (.188)	+12.6 (.314)
		%MT*	**-25.3 (.015)**	-19.1 (.200)	**-29.2 (.020)**	-15.9 (.233)
		DN*	-0.1 (.559)	-0.2 (.394)	-0.3 (.243)	-0.1 (.667)
		Pol.†	+2.7 (.719)	-0.7 (.945)	+4.1 (.624)	+7.3 (.427)
	T1 to T3 (pre to follow-up)	%AT*	+9.3 (.367)	**+27.4 (.064)**	+5.3 (.683)	+10.1 (.438)
		%MT*	**-20.4 (.072)**	-24.3 (.126)	**-27.0 (.056)**	-6.2 (.658)
		DN*	+0.3 (.126)	+0.1 (.729)	0.0 (.987)	**+0.4 (.083)**

AT: Active Transport (walking or cycling); MT: Motorized Transport (car or motorcycle). DN: Descriptive social norms. Pol.: Polarity of children's statements during the inquiry sessions (AFINN lexicon, x100).

6.4. Discussion

In this section, the evaluation of changes in perceptions and travel behavior is introduced following the implementation of a 4-month program in public preschools in São Paulo (Brazil). To do this, the impact of two intervention types on young children (5-6 y/o.) and their caregivers was tested: i) weekly inquiry sessions about urban mobility through the Philosophy with Children approach (299 children); and ii) bimonthly outdoor walking activities in part of the sample (87 children). In this way, the impacts of discussing (inquiry sessions) and practicing urban mobility (outdoor walking activities) with young children were observed both on children and their caregivers. As a general result, it was possible to observe that the act of discussing urban mobility as such seems to have a significant impact not only on the perceptions of children (polarity of statements) and caregivers (social norms), but mostly on the reported modal shifts of caregivers towards sustainable mobility, even if they were not direct beneficiaries of the interventions.

The minor variations in children's modal share to access schools seem convergent with children in this age group, whose travel choices are relatively stable (Panter et al., 2013). This converges in a way with the findings by Teixeira et al. (2019), whose tested interventions "were able to create awareness and intentions of change" but needed “more extensive activities throughout time” to effectively change travel behavior (Teixeira et al., 2019, p. 13). However, both inquiry sessions and outdoor walking activities here analyzed over a five-month period seem to have contributed to alter the reported travel behavior of caregivers and certain perceptions of children and their caregivers (polarity of statements during the PwC sessions and social norms, respectively). Moreover, the methods adopted have provided an opportunity to deepen qualitative research designs by capturing the perceptions of preschool-age children (up to 6 years old) using their own words (Barreiros et al., 2019a; Humberto et al., 2020a). In this sense, they seek to bridge the gap of previous research on the influences on travel behavior intention, which has “relied heavily on eliciting information via survey questionnaires and interviews using the researcher’s words" (Line et al., 2010, p. 239).

The major role of the intervention types identified here does not preclude nevertheless the effective role of physical changes in the urban environment in changing and shaping sustainable mobility behaviors, which require a "high degree of political involvement and support" (Christiansen et al., 2014, p. 180) and may be well combined with soft interventions. The integration of initiatives focused on perceptions and attitudes into transport projects might therefore be effective in: i) changing “car use intentions and willingness to accept car restrictions” (Sigurdardottir et al., 2013, p. 1); ii) mitigating “gender inequities in transport cycling” (Bourke et al., 2019, p. 64); and iii) promoting “well-planned natural experiments focusing on AST [active school transportation]” based on the "engagement of local authorities [that] can form the basis for solid knowledge of promoting active transportation for the generations to come” (Christiansen et al., 2014, p. 180). In this research, even though outdoor walking activities and inquiry sessions did not have the encouragement of sustainable mobility as a common objective, the changes observed towards active modes in both behavior and perceptions seem to have occurred primarily as a result of the experience in the participatory debates in the classroom, which in some cases had their effects reinforced by participating in the outdoor walking activities around schools.

However, a thorough analysis of the changes identified is needed, as the difficulties in reaching new levels for sustainable mobility may be influenced by different baseline values. A first consideration refers to the high share of pedestrian trips by children in accessing schools, which is above average for the city of São Paulo and might explain the modest modal shifts identified towards active modes. Among the caregivers, with an active modal share below the city average, significant modal shifts were identified in two directions: i) a 45% increase in the

adoption of active modes, which was sustained in the follow-up, and ii) a 12% decrease in motorized transport use, notwithstanding a mild recovery after the winter school break (T3), with greater reductions among caregivers whose children were involved in both interventions (I2). This rationale can be similarly applied to the stratified analyses, where the most prominent modal shifts analyzed were observed in groups with the lowest active modal shares (caregivers of boys, native children and those in low social vulnerability), possibly with greater likelihood of shifting to active modes compared with girls or vulnerable children, for instance.

Once these changes are acknowledged, one should inquire about the factors that seem to determine such shifts in the perceptions and transport modes, i.e., how the cycle of these changes is unfolded. The findings of this study may be useful to observe the impact of encouraging dialogue and the practice of urban mobility with children on the perception of their caregivers, which in turn changed their mobility behavior. However, how can the cycle of behavior change in urban transport be understood considering the child-caregiver relationship? Have children's statements during the inquiry sessions at school been raised in discussions back home and directly influenced their caregivers' travel behavior? Or had children's statements affected at first the caregivers' social norms and thereby changed their travel behavior? Could a reinforcement loop towards more active mobility be triggered by such school-based interventions?

This debate is convergent with the positive impacts on the family environment and the social-emotional development of children that are promoted by the Philosophy for/with Children inquiry approach by increasing “organic and sincere dialogue between parents, teachers and students” (Papathanasiou, 2019, pp. 22–23). It is also in line with interventions in the field of environmental education in schools, in which programs "received by children indirectly influenced their parents in recycling paper, plastics, and tin cans" (Evans et al., 1996, p. 243). This points out that even children this young, who still rely on their caregivers for many activities, have agency and constitute a culture of their own to discuss relevant transport-related aspects, besides having the potential to promote behavior change in their households. This indicates the significant role of children as social actors and of childhood as a social category, which resonates with Sarmento et al.’s (2018) critique on the “ideas about ‘vulnerability’ and ‘innocence’ usually attributed to childhood”, whose acknowledgment might endorse a “renewed vision of childhood such as those related to agency, childhood cultures, public policies for childhood and social practices, and institutional settings for children” (Sarmento et al., 2018, p. 136).

These considerations suggest possible lessons for the evaluation of child-centered interventions in the transport domain, particularly with regard to the role of perceptions and early childhood in behavioral changes involving school-based interventions towards sustainable

transportation. First, the perceptions seem to indicate triggers for behavior change and might be the starting point for future measures, converging with the suggestion brought by Gutierrez et al. (2014) regarding the “prioritization towards engaging in and acknowledging safety before physical activity” (p. 116) to promote active transportation with children. Furthermore, the participatory and pragmatic aspect of combining discussion and practice with children may overcome the challenges found in shifting parental attitudes, such as the ones found by Ducheyne et al. (2014) in cycle training with children, where “multiple efforts might be needed to change parental attitudes” (p. 59). In this manuscript, changes in both descriptive social norms and travel behavior were identified in the caregivers, even though they were not the direct beneficiaries of the proposed interventions.

In addition, although no significant increase in active modal share has been identified among children to access schools, this positive impact has been detected in the reported travel behavior of caregivers. This observed effect may unravel intra-household interactions beyond the monodirectional influence of adults on children and indicates potential pathways for the impact assessment of school-based interventions on sustainable habits. Furthermore, this may also disclose the possible impact of parental behavioral changes on children, such as the primary focus on "attitude and behaviour change among parents to grant children more freedom” suggested by (Vlaar et al., 2019, p. 8) to design "future interventions to increase children’s territorial range" (*Ibid.*). Finally, the context of Brazilian public schools analyzed in this study may also contribute to the yet under-studied research agenda on the Global South with regard to the travel behavior of children and their caregivers.

Evidently, it is difficult to claim (nor was it the objective of the present research) that long-term effects may persist in this group of children and caregivers involved in these interventions, particularly in a context of large-scale economic and social repercussions brought by the COVID-19 pandemic in 2020. Still, it would be of particular importance to assess the persistence of the gaps identified between children from different nationalities and social vulnerability levels, as well as to verify whether the impact of these interventions at an early stage are somehow correlated with permanent changes in behavior, such as the significant influence of school-age physical activity on adult physical activity identified among 9 to 18 year old children (Telama et al., 2005). In addition, the quarantines enforced by the spread of the novel coronavirus might prompt long-lasting changes in the travel behavior and social norms related to urban mobility, since the COVID-19 pandemic has implications in many spheres relevant to transport issues, including school closures, occupation of public places, changes in work routines, family organization, and isolation, leading to feelings of insecurity and avoidance of crowds (Brooks et al., 2020; Ornell et al., 2020).

7. Conclusion

In this doctoral thesis, a number of outcomes were pursued based on the overarching goal of **evaluating the effects of school-based interventions on changing the travel behavior of children and their caregivers**, which are associated to a set of key research questions (see Table 26).

Table 26: Doctoral research's key research questions (K-RQ). Equivalent to Table 1 (section 1.1).

Key Research questions (K-RQ)	
K-RQ1	How can we capture and understand the way mobility capabilities enable the different mobility functionings in early childhood?
K-RQ2	How can we incorporate the views and perceptions of preliterate younger children into travel behavior research?
K-RQ3	Do specific interventions in schools affect the travel behavior of children and caregivers in the short term?

Similarly, these outcomes followed a number of specific objectives and specific research questions associated to the key research questions, as indicated in section 1.1. To achieve them, an Action Research was proposed using a mixed methods approach, in which the Capability Approach was incorporated to examine the socio-spatial inequalities of children in accessing schools. That enabled selecting suitable schools for data collection, where two different intervention types aimed at changing the travel behavior of children and their caregivers were implemented. The data collected were assessed using a set of data analysis approaches, including statistical modelling tools and text mining techniques. As in section 3.1 (Figure 1), the methodological steps are resumed in order to facilitate the understanding of the thesis as a whole, in Figure 35 below.

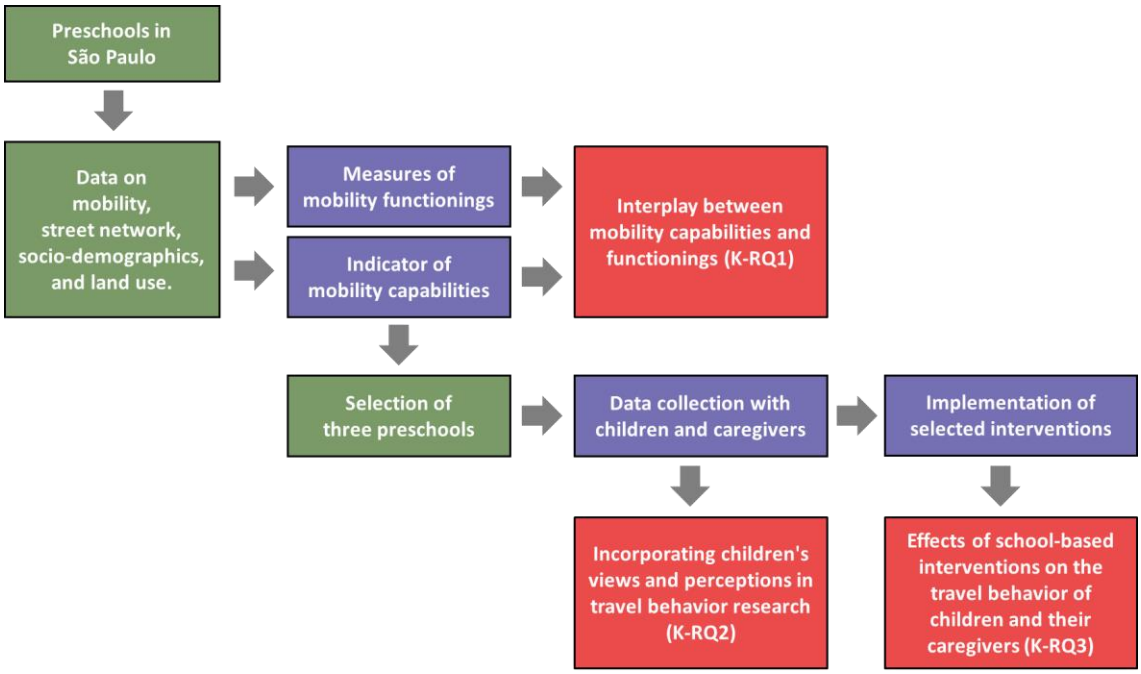

Figure 35: General schematic representation of the proposed methodological steps and associated key research questions (K-RQ). Equivalent to Figure 1 (section 3.1).

The first key research question (K-RQ1) provided the opportunity to examine and conceptualize the vectors of capabilities and functionings of preschools and nurseries in the city of São Paulo (Brazil), focusing on walking mobility and the differences between public and private schools.

Apart from the conceptualization of some CA concepts within the mobility domain (for instance mobility resources, capabilities, functionings and the gap between functionings and capabilities), the operationalization of such metrics in the case of preschools in São Paulo enabled addressing socio-spatial inequalities in transportation involving children, which corroborated with class and race disparities in the access to education in Brazil. As a general outcome, schools with poorer conditions to walk do not seem to have any other options than walking to go to school (*e.g.* transit or bicycle). On the other hand, schools in wealthier regions seem to present barriers to the fulfilment of active mobility even when the resources are considered sufficient, in which the implementation of educational programs was recommended. In addition, the aggregation method used to estimate the level of resources (conditions to walk), was based on a set of measures using the Capability Approach that seeks to minimize the compensation of a metric's low performance by a high score by another metric, which might offer some alternatives to the additive compensatory methods that are commonly applied in the development of multicriteria indexes in the transport domain.

As a means to address the second key research question (K-RQ2), some experiences of incorporating children's views and perceptions about urban mobility were investigated, followed by the implementation of structured approaches for data collection and analysis stemming from empirical research conducted in public preschools of São Paulo (Brazil).

In this way, the potential of the Philosophy with Children inquiry approach to capture perceptions from the point of view of children was recognized, as well as the role of younger children (aged 5-6 years old) in providing valuable insights about transport-related topics. Similarly, the potential of text mining techniques to analyze large qualitative datasets (in this case transcripts of the inquiry sessions) was acknowledged, namely through topic modelling and sentiment analysis. In this sense, motorized transport was found to be associated to more negative comments about urban mobility, and the nationality and social vulnerability of children seemed to affect children's views on transport in a significant way.

Finally, the third key research question (K-RQ3) prompted the evaluation of travel behavior changes following the implementation of a school-based program based on two intervention types: i) exploration of the open public space in the surroundings of schools through outdoor walking activities; and ii) inquiry sessions about urban mobility through the "Philosophy with Children" participatory approach.

In addition to identifying some effectiveness of child-centered interventions on the travel behavior of caregivers, the role of perceptions and early childhood on behavioral changes towards sustainability was also observed. Furthermore, the child-caregiver relationship was found to be relevant in travel behavior research, which provided some insights on the cycle of behavior change given the child-caregiver relationship.

The application of an empirical research design involving children through Action Research has shown to be possible in the context of a Global South country. The proposed AR project seems to have been greatly facilitated by the proximity that was built up with children and their caregivers and schoolteachers throughout the research project in the selected schools. Over the course of six months of data collection and of implementation of the intervention types it was possible to take part of the school environment on a frequent and participative basis, including the weekly meetings with the school staff and bimonthly meetings with caregivers. The participatory aspect of the research carried out seems similar to the discussions on the "careful familiarization with existing practice" in the early applications of Action Research in the school setting (Laishley and Coleman, 1978, p. 224), in which "a rather longer-term perspective developed for some staff" supported "a greater willingness to observe and keep brief records" (Laishley and Coleman, 1978, p. 223).

Also in comparison to other initiatives involving Action Research with children, the experience reported in this thesis seems aligned when the proposed strategies (Philosophy with Children inquiry approach and Outdoor walking activities) are observed more thoroughly. The inquiry approach, as the name implies, is tailor-made for the age group of the children covered by this project and sought to incorporate along the school semester some topics that seemed instigating for both children and schoolteachers, since a significant part of the class teachers sought to associate some reading, play and other literacy projects with the topics developed along the research project.

In a similar way, the outdoor walking activities considered aspects of each school's surroundings, which encouraged children to explore the neighborhood in which most of them were living, including the local businesses, the playgrounds used by them and other community spaces. Some schoolteachers also benefited from walking activities to introduce aspects of the neighborhood's local geography that could be aligned with the pedagogical approach of early childhood education. That seems to be convergent with the "developmentally appropriate" experiences of AR with children suggested by teacher Maureen Awbrey (1987), in which one "must recognize that the children will be at various stages of development" and "must be able to recognize these various stages and provide each child with appropriate activities for growth" (Awbrey, 1987, p. 58).

In this sense, the support provided by the local NGO to elaborate the outdoor activities (*apē estudos em mobilidade*) also played a crucial role to ensure that the activities were not only suitable to children and local context, but also fun. By producing maps of the surroundings of the schools prior to the activities, the interest of participating children was sustained in a playful way, in addition to guiding them along the route and being used as a tool for collaborative drawing using the items that were collected during the walking activities (for instance leaves, stones, seeds, and papers). This seems pretty aligned with the experience of Action Research with street children brought by Young and Barrett (2001), where "the advantages of this [action research] method for the understanding of children's daily lives" were significantly affected by the playful and action-based aspect of the proposed activities, in which "children found the activity fun and others often asked if they could join in" (Young and Barrett, 2001, p. 144), thus increasing the engagement of children in the proposed school-based activities and promoting possible spillover effects on caregivers as children come back home.

The participation of the local NGO in the empirical research project was in this regard a fundamental factor to ensure safety and security that are determinants to the participation of children in activities outside school, as they seem to be linked to the willingness of caregivers in allowing children to join these activities, which were not common practice in the schools analyzed at that time.

Dealing with Action Research undoubtedly involves problems of implementation and evaluation, including: i) the limited control in the adherence of some teachers in the outdoor walking activities; ii) the staff exchanges throughout the semester in some of the classes; iii) the varied motivations among participating teachers to organize the completion and collection of questionnaires with caregivers; and iv) the difficulties that are routinely faced by public education professionals in Brazil (small, crowded classrooms, infrastructure problems, budget cuts, reduced staff), even if the study was conducted in a city with higher income than the country's average in which elementary education receives a certain priority. However, as with Laishley and Coleman (1978), "such an approach [Action Research] was the most constructive method of intervention with the day nurseries since it combines consideration of the interpersonal factors as well as an attempt to monitor problems and assess successes" (Laishley and Coleman, 1978, p. 224). In order to overcome the difficulties of interventions in on-going institutions, the authors highlight the importance of "a balance between supportive behaviour and an insistence on basic strategies of the intervention", in which “the same programme of intervention can be approached very differently by different nurseries, schools, etc.” (*Ibid.*).

Finally, it seems relevant to remark on the issue of the voices that are often overlooked in transportation planning, as this study has tangled various layers that are commonly understated in travel behavior research, namely public schools in the Global South and populations in social vulnerability, including the situation of younger children in low-income communities. Additionally, the focus of this study on active transport, despite being increasingly addressed by academic literature in recent years (*cf.* section 2.3), is still largely neglected in most of the transport policies in the real world, even if active modes constitute most of the home-to-school trips in a number of countries of the Global South, and also considering all trip purposes in some contexts, as is the case of the city of São Paulo that is analyzed here (Vasconcellos, 2017).

In all facets of the literature review conducted (section 2), the limited presence of studies from and about the Global South seems to point to a reduced focus of academic literature on these contexts. However, this may also represent the difficult conditions that most researchers and research institutions face in these regions, where funding and institutional support are often unavailable to undertake empirical research in vulnerable contexts, including the monitoring of interventions over time, the systematic collection of primary data, and careful analysis of both qualitative and quantitative data, which tend to involve more demanding research designs.

In addition, the growing social and political divides in Brazil and in other parts of the world have imposed a series of obstacles related to the implementation of research on travel behavior, especially with regard to the development of public policies and to research agendas that seek to bring the status quo and pre-established norms into question, as with a reasonable number of

transport projects that seek to promote more sustainable mobility by reducing car use, implementing facilities for active modes and reducing greenhouse gas emissions. As a result, interdisciplinary projects with some social purpose may be supported less by research agencies. Similarly, the interactions of some steps of field academic research with community members may experience greater constraints, with some sectors of society being less likely to collaborate with academic projects, accompanied by the recent emergence of an anti-scientific mindset.

This thesis seeks to bring a small but clear contribution to the field of transport policies and travel behavior research through the case of young children and their caregivers that were consulted in a set of public preschools of São Paulo. Meanwhile, this thesis also intends to constitute one of the studies seeking to transpose the academic disciplinary curricula, by modestly and preliminarily reconciling some of the knowledge stemming from areas that are typically disconnected from engineering and transportation, such as philosophy and education. It also seeks to recover the social purpose of studies supported by public funding and institutions, considering the existing social dynamics in an indissociable way with technique, academic discipline, questioning, and reasoning.

In the following sections, the three key research questions and respective specific research questions (introduced in section 1.1) are revisited, in which applicable responses are provided. These are followed by the identification of the main limitations of this research project and the indication of possible avenues for future research, which conclude the main body of this doctoral thesis.

7.1. Revisiting the research questions

In this section, the research questions established in section 1.1 are revisited (key research questions and specific research questions), in which applicable responses are provided, together with the respective sections where they can be better explored throughout the thesis.

7.1.1. Key research question no. 1

K-RQ1. *How can we capture and understand the way mobility capabilities enable the different mobility functionings in early childhood?*

From the review of the literature about the intersections of the Capability Approach with the travel behavior of children, it was possible to conceptualize a set of CA-based metrics that are suitable for addressing socio-spatial inequalities in transportation. This enabled assessing the conditions in the access to schools by children from the available data, as well as examining the interplay between the mobility capabilities and functionings in the case of preschools and nurseries in São Paulo.

7.1.1.1. Variables indicating the mobility capabilities of children and caregivers (specific objective no. 1)

S-RQ1. *How can the Capability Approach be integrated into the domain of mobility behavior analysis?*

From the literature review on the intersections of the Capability Approach with the travel behavior of children (section 2.1), it was possible to examine the references that address the operationalization of the CA through quantitative approaches, especially in the case of studies related to urban mobility, children and education, as well as on the issue of collective capabilities.

S-RQ2. *Can a 'mobility capability' and 'mobility functioning' be quantitatively observed?*

From the literature review (see response to S-RQ1 above), it was possible to develop a set of metrics from the Capability Approach that are suitable for the examination of socio-spatial inequalities in São Paulo, as conceptualized in sections 3.3 and applied for preschools and nurseries in São Paulo in sections 4.2 and 4.3. These metrics include the mobility functionings (effective mobility), resources (conditions that might promote effective mobility), the capabilities (ability of given resources to achieve effective mobility), the conversion factors

(parameters or functions that relate the resources and the functionings), and the gaps between functionings and capabilities.

$Functionings = f(Resources)$; f: conversion factor;

$Capabilities = g(Resources)$; $f(.) \approx g(.)$;

$Gap = Functionings - Capabilities = f(Resources) - g(Resources)$.

S-RQ3. *What variables might indicate the degrees of mobility capability and mobility functioning of children and their caregivers?*

A set of CA-based metrics was developed for the examination of socio-spatial inequalities in São Paulo, as covered in the response to S-RQ2 above. These metrics enabled measuring the conditions of access to preschools and nurseries in São Paulo from the available data, namely the conditions of street lighting, paved streets, sidewalks, open sewage, litter, road safety, and population density. From that, the conditions to walk (resources) and the share of pedestrian trips (mobility functionings) were calculated, which enabled the estimation of the conversion factors and mobility capabilities at the school level based on the Capability Approach. The methodological steps and respective outcomes can be specifically found in sections 4.2 to 4.4.

7.1.1.2. Indicators of mobility capabilities and functionings of schools (specific objective no. 2)

S-RQ4. *What variables define the mobility capabilities of preschoolers within an urban area? Which of them regard data on the surroundings of schools (e.g. coverage of sidewalks)?*

As mentioned in the response to S-RQ3 above, a set of variables related to mobility, road safety and the built environment was grouped to evaluate the access of children to preschools and nurseries in São Paulo from the available data.

These variables enabled estimating the metrics related to the resources (conditions to walk) and the mobility functionings (share of pedestrian trips). The obtained metrics could be related using a simple linear regression model and yielded the conversion factors (regression parameters). Then, the obtained regression parameters were assumed to be equivalent to the function relating the mobility capabilities and the resources, which allowed for the estimation of the mobility capabilities and the gaps between functionings and capabilities, as indicated in the response to S-RQ2 above.

S-RQ5. *What is the adequate scale of aggregation (e.g. buffer size and extent of service area around schools) of data on the surroundings of schools?*

As explored in Humberto et al. (2018b), the scale of aggregation that best relates the conditions of mobility, road safety and built environment to children's transport was 2,000 meters around schools, which corresponds to a 30-minute walking distance for a preschool-age child and is commonly adopted in Brazil as the threshold distance beyond which the school bus services are provided by the public sector. In addition, service areas were also found to better address the conditions of children in accessing schools, as compared with buffers using Euclidean distance. Further details can be found specifically in section 4.2.

S-RQ6. *How can capability metrics be aggregated into a compound indicator focusing on active mobility?*

As presented in the responses previously presented, a set of variables related to mobility, road safety and the built environment was grouped to estimate the available resources (*cf.* response to S-RQ3), which enabled the computation of the mobility capabilities (*cf.* response to S-RQ2). To do this, relevant thresholds were assigned to each variable to classify the schools in a binary way, i.e., 1 (capable), and 0 (non-capable). Similarly, the expected correlation signs of each variable with the dependent variable (positive or negative) were determined according to relevant literature. Finally, for the aggregation of the variables into a composite measure, the binary values associated to each of the variables were grouped using equal weights through a simple additive compensatory method. More details on this topic can be found specifically in section 4.3.1.

S-RQ7. *Are there relationships between the capability indicators and the mobility functionings? If so, how are they related?*

From the review of the literature about the CA (*cf.* response to S-RQ1), it was possible to conceptualize and operationalize relevant metrics for the evaluation of the conditions encountered by children to access schools (*cf.* responses to S-RQ2 and S-RQ3). As indicated in the response to S-RQ2, the gap between functionings and capabilities provides the ability to observe the circumstances that seem to drive a share of pedestrian trips below what is expected for a given level of resources, and vice-versa. This metric relating the mobility capabilities and functionings therefore provides a useful tool to measure socio-spatial inequalities, since, in the specific case of preschools and nurseries, it was able to address the transport disparities in school transportation that are reported in São Paulo (see discussion in section 4.5 and also Moreno-Monroy et al., 2018).

S-RQ8. *Can the capability indicators be evaluated in terms of potential to promote mobility functionings? Can they guide the selection of appropriate sites for data collection?*

Insofar as mobility capabilities seek to estimate a school's ability to achieve higher mobility functionings (in this case the share of pedestrian trips), the measures of capabilities obtained appear to be adequate measures for selecting suitable schools for comparative research. In this sense, the public schools selected present quite similar levels of conditions to walk (resources). In addition, a criterion of no fatal accidents involving children reported in the last ten years was also adopted in order to avoid possible constraints to the implementation of the intervention types, especially the outdoor walking activities. Notwithstanding being a measure derived from the mobility capabilities, the conditions to walk (resources) can also be utilized in this criterion, since only public schools were considered for this study, which have different conversion functions in comparison to private schools. Please refer to the response to S-RQ2 above for more details on the estimation of resources and mobility capabilities.

7.1.2. Key research question no. 2

K-RQ2. *How can we incorporate the views and perceptions of preliterate younger children into travel behavior research?*

As found in the review of the literature on the methods to incorporate children's views about urban mobility (section 2.2), there are few studies regarding the voices of children under eight years old in transport research. This limitation is exacerbated when the study design is established in preschools (up to six years old), especially because these children are preliterate , i.e., they are still unable to write or fill out the questionnaires that are usually adopted in travel behavior research. In this sense, the potential of "Philosophy with Children" inquiry approach to capture perceptions from the point of view of children in a thorough way was explored, especially by participating in conferences, publishing in a philosophy and education-related journal and through a workshop specifically organized for the team of researchers of the empirical research. In addition, the challenge of dealing with large databases resulting from intentionally unstructured forms of interaction with children has prompted the search for adequate methods of qualitative data analysis.

7.1.2.1. Method to capture perceptions of younger children about urban mobility (specific objective no. 3)

S-RQ9. *How can we develop and test a method to capture the views and perceptions of younger children about urban mobility?*

The configuration of the inquiry sessions adopted in the empirical research was defined through a pilot study in 2017 in a nursery school in Lisbon (Portugal), which was later presented in a biannual conference of the International Council of Philosophical Inquiry with Children (Barreiros et al., 2019b) and whose insights were published in a peer-reviewed journal (Barreiros et al., 2019a). In addition, the team of researchers involved participated in a workshop provided by the "Philosophy and Children Studies Group" (Rio de Janeiro State University, http://www.filoeduc.org/) two months before the beginning of the project, which was then followed by reading sessions and the collaborative development of the inquiry sessions, on a weekly basis. More details of the methodology adopted can be found in sections 3.5.1.1 and 3.6.1.

S-RQ10. *What are the available methods for analyzing large qualitative datasets collected with younger children in a structured way?*

The transcription of the PwC sessions originally contained 38,369 segments of text, corresponding to comments of the participants during the PwC sessions. Once the statements made by adults (school staff and participating researchers) were filtered out, and only the statements in selected inquiry sessions and containing data provided by the questionnaires to caregivers were selected, this resulted in a reduced dataset containing 7,934 segments of text, which is the database used throughout this research project.

Transcripts of qualitative datasets are typically coded and categorized following predetermined frameworks and models for children's mobility, which however was impractical under this doctoral research considering the size of the dataset obtained and the available resources, despite using a reduced dataset. In this sense, a set of text mining techniques was found adequate to analyze large qualitative datasets and to support travel behavior research, namely through topic modelling and sentiment analysis. More details on this topic can be found specifically in section 3.7.1.

7.1.3. Key research question no. 3

K-RQ3. *Do specific interventions in schools affect the travel behavior of children and caregivers in the short term?*

Two specific intervention types were tested as part of a 4-month program in selected preschools in São Paulo: a) weekly inquiry sessions about urban mobility through the Philosophy with Children (PwC) approach and b) bimonthly outdoor walking activities in the surroundings of schools.

To monitor the implementation of these school-based interventions, a set of variables was collected from children's caregivers through questionnaires, namely socio-demographic variables, the adopted transport modes by children and caregivers, and social norms towards active mobility. These questionnaires were completed in three stages of the project implementation: i) two weeks before the beginning of the PwC sessions (T1: pre); ii) at the end of the proposed interventions in schools (T2: post, four months after T1); and iii) after winter school break (T3: follow-up, six months after T1). Likewise, children's perceptions were obtained through the transcripts of the inquiry sessions (sentiment analysis). In this way, it was possible to observe positive changes in the perceptions of children's statements and in the social norms of their caregivers about transportation, as well as significant modal shifts as reported by caregivers towards sustainable mobility. Besides the identification of changes in the behavior of adult caregivers through child-centered intervention types, this empirical research enabled unraveling the effect of the proposed measures according to the child's gender, nationality, and level of social vulnerability, including the significant modal shifts towards walking and cycling identified among caregivers of boys and out of car and motorcycle among those of native children, which were significant both in post and follow-up measures

7.1.3.1. Monitoring of selected interventions regarding the promotion of active mobility capabilities (specific objective no. 4)

S-RQ11. *How can the collected data from children and their caregivers be associated and analyzed?*

The qualitative datasets could be combined with the information from the questionnaire for caregivers, once the names of the children were pseudomized, which allowed for a joint analysis of children's statements and the information provided by caregivers over time, as well as the association of secondary databases using individual variables such as the housing conditions and

the levels of social vulnerability. These procedures, which followed the recommendations of the Research Ethics Committee, allowed the stratification of the analyses into relevant categories such as gender, nationality and level of social vulnerability, as demonstrated specifically in sections 5.3.2 and 6.3. Details on the Research Ethics Committee approval and respective guidelines can be found in *Appendix C: Approval by Research Ethics Committee and Department of Education*.

S-RQ12. *Which are the existing interventions seeking to promote mobility capabilities with children? How are the caregivers involved? How are their evaluation methods like?*

From the literature review on the interventions aimed at changing the travel behavior of children (section 2.3), it was possible to examine the empirical studies covering changes in the travel behavior of children using a pre/post research design according to the type of intervention, sample size, age range of children, consultation to children/caregivers, and the identification of strategies with significant (positive) effects on active commuting or physical activity.

S-RQ13. *Which are the available methods for assessing changes in the travel behavior of children and their caregivers following a school-based intervention?*

Although the empirical literature on children's voices in travel behavior research (section 2.2) revealed a wide range of strategies seeking to incorporate the perceptions of children in transport planning (for instance drawings, photography, photovoice, activity-travel diaries, focus groups, and questionnaires), it has tended to overlook the opinions of children, especially the younger ones, in a participatory way. In addition, the research methods adopted in children's travel behavior commonly disregarded structured analytical tools to deal with both qualitative and quantitative data in a reproducible way, including analysis over time and comparative evaluations.

Furthermore, the literature covering the travel behavioral changes of children (section 2.3) has indeed recognized the influence of perceptions, attitudes, and psychosocial determinants on travel behavior through a wide range of interventions (school travel plans, Walking School Bus, cycle training courses, and physical activity interventions etc.). However, the issues concerning the child-caregiver relationship and the methods for examining both perceptions and the effective mobility of children are still under-researched, especially in the context of younger children from the Global South. To deal with the comparative assessment of the intervention types over time that was proposed in this doctoral thesis, two approaches were brought from a set of quantitative methods commonly used in economic and health assessments for the

estimation of policy effects, namely difference-in-differences analysis and time-series analysis (also known as interrupted time-series). Further details can be found specifically in sections 2.2 and 2.3.

7.1.3.2. Correlates of travel behavior change due to school-based interventions (specific objective no. 5)

S-RQ14. *What are the correlates of mobility capabilities of children and their caregivers? What are the correlates of active transport to school? Are these related?*

In the empirical research conducted, the transport modes of adult caregivers and children were surveyed, although both were reported by the respective caregivers through the questionnaires. Likewise, the children's perceptions were obtained through the inquiry sessions (sentiment analysis) and the caregivers' social norms through the questionnaires, which are related to the mobility capabilities of children and their caregivers, respectively. The analysis of these measures before the beginning of the project (T1: pre) allows us to identify a set of factors that seem to be correlated to the mobility capabilities and functionings of children and caregivers.

In relation to the mobility functionings (share of active trips), only nationality seems to play a relevant role in the adoption of active modes by caregivers; however, in the school transportation of children there seems to be a bias among girls, non-native children and those in high social vulnerability towards higher rates of walking trips. These measures are inversely related to functionings of motorized modes.

The mobility capabilities seem to follow another pattern, in which there seems to be no significant bias in the descriptive social norms of caregivers. In the case of children, girls present more positive comments during the inquiry sessions, which seems to be in line with the differences found in the active mobility functionings. However, this pattern is reversed when the nationalities and levels of social vulnerability of children are observed, since higher polarities seem to be found between native children and those in low social vulnerability, contrary to the pattern found in the active mobility functionings. More details on the correlates of mobility functionings and capabilities of children and caregivers can be found in section 6.3.

S-RQ15. *What are the perceived changes in the travel behavior of children and their caregivers due to the selected interventions in schools?*

In this doctoral thesis, two intervention types were tested during a 4-month program in selected preschools: a) weekly inquiry sessions about urban mobility through the Philosophy with Children (PwC) approach and b) bimonthly outdoor walking activities in the surroundings of schools. To monitor the implementation of these school-based interventions, a set of variables was collected from children's caregivers through questionnaires, namely socio-demographic variables, the adopted transport modes by children and caregivers, and social norms towards active mobility. These questionnaires were completed in three stages of the project implementation: i) two weeks before the beginning of the PwC sessions (T1: pre); ii) at the end of the proposed interventions in schools (T2: post, four months after T1); and iii) after winter school break (T3: follow-up, six months after T1). Likewise, children's perceptions were obtained through the transcripts of the inquiry sessions (sentiment analysis). In this way, it was possible to observe positive changes in the perceptions of children's statements and in the social norms of their caregivers about transportation, as well as significant modal shifts as reported by caregivers towards sustainable mobility, which were evaluated using difference-in-differences and time-series analyses. Further details can be found specifically in sections 6.3 and 6.4.

7.2. Limitations

The methods adopted in this doctoral research present some limitations and a set of considerations must be underscored. Regarding the theoretical perspective that was established for this project, the participative and continual nature of Action Research did not lead to a methodological design with stringent monitoring nor the existence of standard controlled evaluations (treatment *vs.* control groups). In this sense, the inexistence of a neat baseline intervention may have undermined some of the research outputs, which were limited to comparing the implemented combinations of interventions in schools (baseline intervention *vs.* combination of interventions). This aspect is extremely relevant in the realization of empirical research in public schools in the Global South, where there are barely any research projects that accompany the dynamics of these institutions throughout a full school semester, in addition to a lack of funding and human resources for studies related to education, urban mobility and other child-related issues as a whole.

In this sense, there is a legitimate demand on the part of schools and their respective boards of education for partnerships that bring added value to the educational activities carried out in schools, rather than simply collecting data with no clear prospect of social, educational or pedagogical return to the school and children involved. In addition, some of the circumstances prevailing in public schools hindered the implementation of interventions as initially stipulated. This can be verified for instance by the negative impacts of the negligence with public education, where the major impacts of a municipal strike made it impossible to have a fourth school in the study design. In addition, there were unexpected effects in the adoption of outdoor walking activities by schools, in which it was not possible to carry out these interventions in school 3 (contrary to the original plan), and one of the classes in school 2 opted to do its outdoor walking activities on its own, which ended up being examined under this thesis.

With regard to the criteria for selecting schools, public schools with similar levels of resources and mobility capabilities were sought for screening, based on the Capability Approach. The absence of a fourth school led to a bias in relation to the mobility functionings of schools, where schools 1 and 2 had higher rates of active mobility, while school 3 (similar to school 4) had lower rates of walking and greater use of public transportation. This was balanced by a larger number of classes in school 3 (four classes) compared to the other schools (two classes in school 1 and three classes in school 2). However, the data used to measure the mobility functionings dates back to 2007, more than ten years before the empirical research project was carried out. The most recent data from the Origin-Destination survey were not available until well after the selection of schools, in mid-2018. The data used were therefore the most recent

available at the time, which, however, must be considered a limitation of this study, especially in relation to the development of mobility functionings (share of pedestrian trips), as well as to the criteria for selecting schools to undertake the empirical research.

In the investigation of the mobility capabilities and functionings in preschools and nurseries of São Paulo (section 4), the composition of the indicator regarding the resources was limited to the appraisal of particular variables on road safety and the built environment. Despite being relevant according to a set of studies regarding school transportation (Sirard and Slater 2008), it does not consider other factors at the neighborhood level that might promote a higher share of pedestrian trips to school, such as the existence of busy road barrier, mixed land use, and the slope of the street network.

Furthermore, setting the median as the threshold value for all variables that compose the conditions to walk (resources) presents convenient simplifications regarding the classification of the schools as capable (1) and non-capable (0) for each variable, since it identifies values that divide the analyzed schools in two groups with the same size. However, that exempts the definition of relevant threshold from the public eye, besides being driven exclusively by the data available. In this sense, organizing public discussion on the parameters set is recommended, in order to correctly identify the thresholds that are relevant for each metric. The same issue of public discussion and methodological simplification can be transposed to the eliciting of weights, since non-equal weights can be elicited either for variables within the same theme or for the relationship between the themes that are being covered.

Moreover, the concept of the gaps between functionings and capabilities here presented does not encompass possible underlying disparities and constraints related to walking. Especially in Global South countries, it is a relevant issue when one walks either as an optional mode of transport (rather than using the transit, being driven, etc.) or as the only mode of transport available (due to non-coverage of public transport, to financial limitations, etc.). That could be appraised in further studies by including the individual reasons and motivations to walk to and from school and by considering an indicator of public transport accessibility and car ownership.

Regarding the incorporation of children's voices in travel behavior research (section 5), the composition and the polarity of the children's statements did not consider imbalances regarding the frequency of speech of children during the PwC sessions, where the preponderance of statements by talkative children may have stood out from the other children, particularly the non-natives who do not have a command of the local language. This is directly related to the non-association of the statements with the classroom attendance lists, since any bias in the

presence of children in specific sessions may affect the composition of the topics and the sentiments associated with the sessions.

In addition, the data from children were originally collected in Portuguese (and partially in Spanish) and then translated to English to be associated to available lexicons, which might bring some limitations to the information provided by children, specially in the case of younger children. Moreover, the AFINN and Bing lexicons used were not developed to the scope of this work and might wrongly classify some terms, which could be improved by developing lexicons that are specific to the context of urban mobility and to the language of young children.

Finally, when evaluating the effects of school-based interventions on the travel behavior of children and caregivers, some limitations can also be outlined. Similar to other empirical qualitative research, there is a concern of social-desirability bias, whose mitigation was pursued through the adoption of the PwC participatory approach, which seeks to build the “experiences of thinking” from the children's questionings, in which the participating researchers seek to intervene only to gather collective questions and inquiries and to select themes to keep discussing in the following inquiry sessions (Gomes, 2019).

Additionally, there is a risk of recall bias in the methods adopted due to the adoption of self-reported measures provided in the questionnaire to caregivers. However, the information collected from caregivers addresses common events such as the usual means of transport and the current perception of pedestrian mobility. Data from children were gathered using a long-running qualitative research design, in which children have more time to recall and elaborate on change, especially when compared to self-administered surveys that are commonly applied in travel behavior research (Janke and Handy, 2019).

Possible idiosyncrasies associated with each of the participating schools were not considered, which may have omitted possible particularities of each school to promote active mobility. In addition, the distinct role of walking and cycling within active mobility was not considered, which may have overlooked possible singularities associated with the population groups analyzed. Finally, this study draws on the caregivers' statements to measure the modal shifts identified, which may present some limitations regarding the accuracy of these measures, possible biases (for instance literacy level), and the comparison of effects between children and caregivers, as the variables related to transport use that are collected throughout the study (T1, T2, and T3) refer to school trips for children and "during the week" for caregivers. As other limitations, the reviewed studies did not include manuscripts that were not written in English, which may result in incomplete representation of the relevant literature.

The methods of data analysis also present some limitations, mainly related to the adopted approaches (time-series and difference-in-differences) and the lack of a randomized controlled

trial research design. In time-series analysis, other events occurring around the time of the intervention can be a source of confounding, whereas in the difference-in-differences approach the analyses are highly susceptible to confounding due to between-group differences (Bernal et al., 2019). Besides acknowledging the inability to control possible contemporaneous events during the school semester, the heterogeneity in the walking conditions was sought to be minimized through the selection of public schools with similar conditions to walk as calculated by Humberto et al., 2020b. Still regarding the analytical approaches adopted, this study could benefit from the adoption of other statistical tests such as hypothesis testing, odds ratio, and structural equation modelling. In addition, the difficulties faced by most public schools in developing countries complicate the implementation of research designs without providing clear benefits to the participating schools, i.e., including them as control schools. Similar challenges have also been identified in studies conducted in wealthier countries (Hinckson and Badland, 2011; Østergaard et al., 2015; Shannon et al., 2018).

Finally, several factors relevant to pedestrian travel behavior were not considered in this study, in which the association with walkability measures might be of considerable value. These might comprise traditional measures in the field such as land use, sidewalk width, traffic safety, existence of meeting places, and vigilance perception by pedestrians (Bradshaw, 1993; Moura et al., 2017), as well as other relevant measures relevant to cities in the Global South, including public lighting conditions, existence of vacant lots and narrow passages (for instance stairways and alleys), and pedestrian flow density (Harkot et al., 2017).

7.3. Avenues for future research

To develop future studies, some suggestions can be outlined based on the research carried out in this doctoral thesis. In the case of the metrics based on the Capability Approach, the discussion on "conversion functions", as enunciated by Amartya Sen (1985) to map the "characteristics of commodities into the space of functionings" (Sen, 1985, p. 13), can be better explored in order to obtain conversion functions that go beyond the simplest ways of converting available resources in urban mobility to the mobility functionings, such as fixed parameters or the simple linear regressions that were proposed in section 4. The implementation of these alternative conversion functions may incorporate discontinuous functions, different formats (*e.g.* exponential, logarithmic) and the establishment of maximum and minimum thresholds. In addition, they can combine statistically relevant measures more clearly, including goodness-of-fit measures and quality estimators of statistical models. In addition, the simplicity in determining the weights of the binary variables while developing the composite measure (see section 4.3.1) can be significantly improved through multiple regression models, instead of establishing ad-hoc weights.

Moreover, the proposed methods for estimating the resources, capabilities, and the conversion factors in urban mobility can greatly benefit from the incorporation of metrics related to the accessibility studies in transport, which seeks to unravel the potential impacts of transport infrastructure (Tomasiello et al., 2020) and investigates "the likelihood of traveling a certain amount of time or distance" (Pritchard et al., 2019, p. 388), similarly to the CA.

The incorporation of databases related to security (public safety) and land use can be of great value in improving the measures of walking conditions, which seems to be particularly critical in Global South countries (Harkot et al., 2017). This can be addressed through the inclusion of open datasets on public lighting conditions, existence of vacant lots and narrow passages (for instance stairways and alleys), and pedestrian flow density.

In addition, testing the robustness of the indicator on the resources (conditions to walk) would be very helpful, for instance by means of a sensitivity analysis, in order to verify whether removing variables or changing the weight of the variables that are part of the indicator can significantly modify the levels of resources of preschools. Finally, some other suggestions on the development of CA metrics can be outlined to develop further studies: i) a deeper analysis of the influence of age on the development of mobility capabilities and functionings (rather than stratifying by nurseries and preschools); ii) the adoption of participatory methods to select the variables to compose the indicator on the conditions to walk, to identify relevant thresholds, and to elicit weights of the indicator's metrics and composing themes; iii) the consideration of the distances from children's homes to school rather than its estimation from the reported duration

of trips; iv) the influence of the parents' employment on the mobility behavior of children, i.e., the effect of parental absence on children's time use, as in Cuong and Linh (2016); and v) the assessment of children's independent mobility, *i.e.,* when they are not escorted by adults.

In the incorporation of children's voices in travel behavior research, a promising research path may be associated with the evolution of topics and sentiments associated with children's statements over time in a more granular way. Instead of simply classifying the statements according to the timing of the questionnaires for caregivers (pre, post, and follow-up), one could look at the changes in the topics and polarities of children's statements over the weeks, as well as analyze the evolution of these statements within the same PwC session, using the theme of the specific session to better contextualize the statements and narratives shared by children. Similarly, the data collected from children enable an individualized evaluation of these topics and sentiments over time, which allows a more detailed analysis of the personal variables that may induce differentiated effects by participating in the proposed inquiry sessions.

Furthermore, polarity estimates obtained from AFINN and Bing sentiment lexicons can be used as input for the development of choice models that help to understand the factors that determine more or less positive statements during the inquiry sessions. Could children's statements about some topics of urban mobility be influenced by socioeconomic variables, housing conditions, or even by a conjunction of the adopted modes of transport with variables from the family setting?

Broadening the research design to consider other types of schools can also contribute to understanding the effects that may be associated with greater or lesser modal shifts towards sustainable transport, for instance through the selection of public schools with lower shares of pedestrian trips, as well as schools with different levels of conditions to walk (resources). The same appears to apply to the inclusion of private schools in future research projects, as they usually have lower rates of walking to school and may indicate even higher potential for modal shifts towards active modes.

Comparing the outputs of the sentiment and topic analyses also seems quite promising, instead of only presenting the results separately. In this way, it would be possible to analyze the association of specific topics (*e.g.* "play/risk" and "way to school") with more positive or negative sentiments, as well as to identify statistically significant differences between the identified topics or even between specific terms (for example family members, school or other public spaces). Similarly, the identification of children's statements mentioning specific modes of transport is believed to be an interesting avenue for future research, such as the mention to active modes and the different forms of motorized transport (*e.g.* bus, train, subway, car, motorcycle). This could be done by creating a lexicon of words associated with each mode, for instance walk, walking, strolling, pedestrian, and "on foot" for walking; and train, rail, tramway,

tram, streetcar, trolley, tube, underground, metro, and subway for rail transport. In this way, the identification of specific modes of transport in each statement would allow analyzing in a stratified way the distribution of topics and the estimated polarities using different sentiment lexicons. Similarly, the association of children's statements mentioning specific transport modes with the variables provided by the caregivers could allow observing whether there is a notion of social status oriented towards the private automobile, as well as assessing the existing perceptions regarding active modes and public transport by groups often overlooked in transport studies, in particular children and socially vulnerable populations.

Finally, some other suggestions can be outlined to develop future studies on the incorporation of children's voices in transport research, including: i) development of inquiry sessions that seek to capture the perception about specific transport modes, *e.g.* private cars and collective transportation; ii) implementation of the inquiry sessions with children and youth from other age groups; iii) influence of the parents' employment on the mobility behavior of children, *i.e.*, the effect of parental absence on children's time use; iv) evaluation of the adopted lexicons through validation approaches (*e.g.* filtering out 30% of the segments of text); and v) development of a sentiment lexicon related to transportation issues.

At last, the impact evaluation of the proposed school-based interventions led to various ways to continue the empirical work undertaken. First, the development of more elaborated statistical models is sought to allow observing the *direction* of the changes identified: more positive children's statements (polarity) over time and higher active mobility rates, lower motorized mobility rates, and greater agreement on walking-related descriptive social norms by caregivers throughout the project implementation. This could be achieved, for instance, by means of structural equation models, which would allow analyzing the relationship between the changes in social norms and the changes in the effective mobility habits (*i.e.,* between the mobility capabilities and the mobility functionings, respectively). These models would also provide a better observation of the child-caregivers relationship, and thereby evaluate, for example, whether the child who engaged in the inquiry sessions changed the social norms of her caregiver, and consequently her daily mobility pattern, or whether these changes occurred in another sequence or even simultaneously. In all cases, the incorporation of these models might be helpful in the development of public policies towards sustainable mobility based on school-based interventions.

The engagement of caregivers can be of great interest to throw light on the child-caregiver relationship in travel behavior research and to assess the combined impact of the proposed intervention types, which might be convergent to the findings from previous research involving Action Research with children, in which "the output is at least doubled" when "the home is

involved in any school initiated work" (Awbrey, 1987, p. 59). Similarly, lessons from previous AR approaches with children point out to the potential of visual methods to allow "a high level of child-led participation in research" (Young and Barrett, 2001, p. 141), which were not addressed in this research project, notwithstanding the implementation of inquiry session no. 8 (Review of activities and free drawing) on the graphical representation of previous inquiry sessions, whose transcripts were however not considered in this doctoral research. Similarly, the multi-sensory aspects brought by the soundscape experience of session no. 5 (Listening and discussion of *Projeto Sonora*'s sound installation "Way to school", also not covered in this study) can provide interesting insights to understand children's travel behavior. These aspects could be better addressed in further research projects involving urban mobility, education and children's participation.

In addition, another interesting avenue of research may be related to the continuation of this study through a randomized controlled trial, *i.e.*, by implementing a research design that includes control and treatment groups. In this way it would be possible to examine whether the effects of the baseline intervention established here (PwC inquiry sessions) also occur in contexts where it is not applied. Some other possibilities for further research might include i) evaluating the effects observed through other statistical tests such as hypothesis testing and odds ratio; ii) considering the effects of the proposed intervention types concerning the mode of transport (rather than only active/motorized) and the nationality of children (instead of aggregating non-native nationalities into a single group); iii) conducting follow-up measurements one year later; iv) testing the impact of the intervention types in schools with lower shares of active mobility (e.g. private schools); and v) considering other under-researched age groups, in particular adolescents in secondary school settings.

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Appendix A: Supplementary materials

Table 27: Changes in selected measures following the implementation of the intervention types (coefficient β_3 and respective P-value). Complimentary to the measures presented in Table 25 (section 6.3). All variables here presented refer to children's adopted transport to school (as reported by caregivers).

Analysis			All children	Boys	Natives	Low vulnerability
Time-series	T1 to T2 (pre to post)	%AT	+3.1 (0.513)	+5.2 (0.446)	+3.0 (0.577)	+2.1 (0.743)
		%MT	-2.3 (0.560)	-3.9 (0.476)	-3.2 (0.483)	+3.3 (0.538)
	T1 to T3 (pre to follow-up)	%AT	+2.9 (0.566)	+5.0 (0.481)	+4.6 (0.417)	-5.8 (0.388)
		%MT	-3.2 (0.448)	-2.9 (0.607)	-3.0 (0.544)	+2.9 (0.599)
Diff.-in differences	T1 to T2 (pre to post)	%AT	-10.4 (0.307)	-12.4 (0.405)	-12.7 (0.311)	-7.6 (0.557)
		%MT	+0.8 (0.927)	-3.2 (0.789)	-3.9 (0.715)	+3.5 (0.748)
	T1 to T3 (pre to follow-up)	%AT	-10.5 (0.336)	-11.5 (0.456)	-15.3 (0.264)	-5.5 (0.681)
		%MT	-1.8 (0.845)	-2.5 (0.844)	-8.7 (0.464)	-5.9 (0.594)

AT: Active Transport (walking or cycling); MT: Motorized Transport (car or motorcycle).

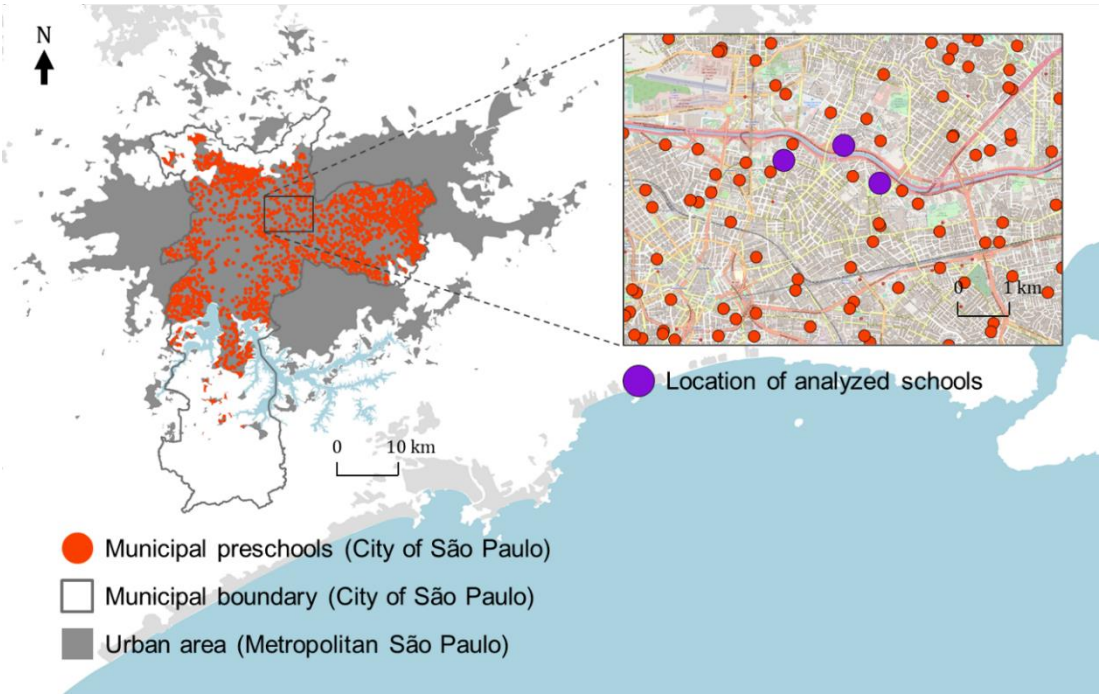


Figure 36: Context of analyzed schools in Metropolitan São Paulo regarding the location of public preschools in the City of São Paulo. Adapted from GeoSampa (2018) and IBGE (2005).

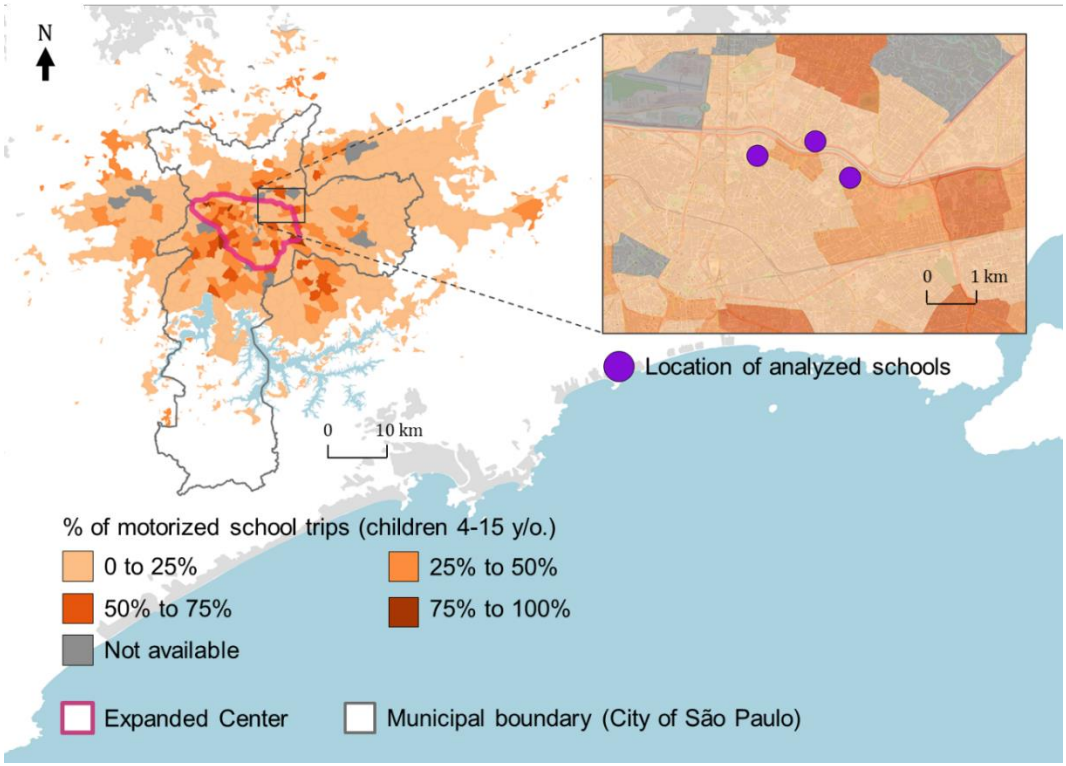


Figure 37: Context of analyzed schools in Metropolitan São Paulo regarding the share of motorized school trips (car or motorcycle) of preschoolers and primary school-aged children (aged 4-15 y/o.). Both public and private schools were considered. Adapted from CET (2013), GeoSampa (2018), IBGE (2005), and METRÔ-SP (2018).

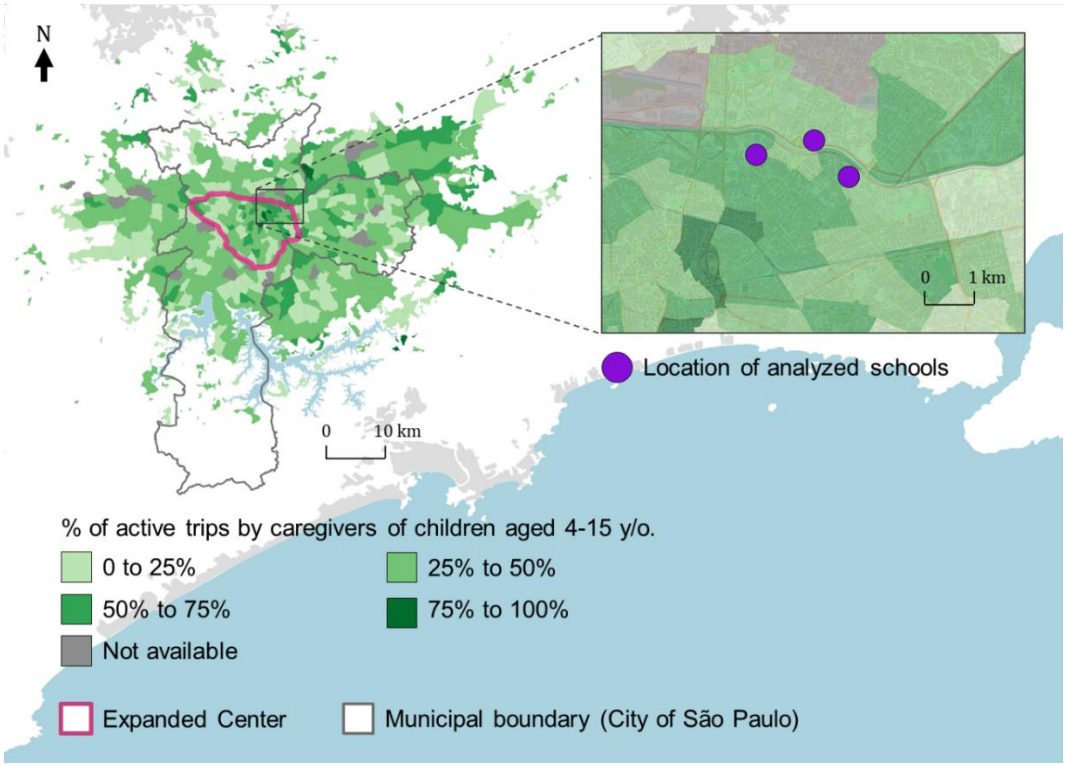


Figure 38: Context of analyzed schools in Metropolitan São Paulo regarding the share of active trips (walking oy bicycle, all purposes) of caregivers of preschoolers and primary school-aged children (aged 4-15 y/o.). Adapted from CET (2013), GeoSampa (2018), IBGE (2005), and METRÔ-SP (2018).

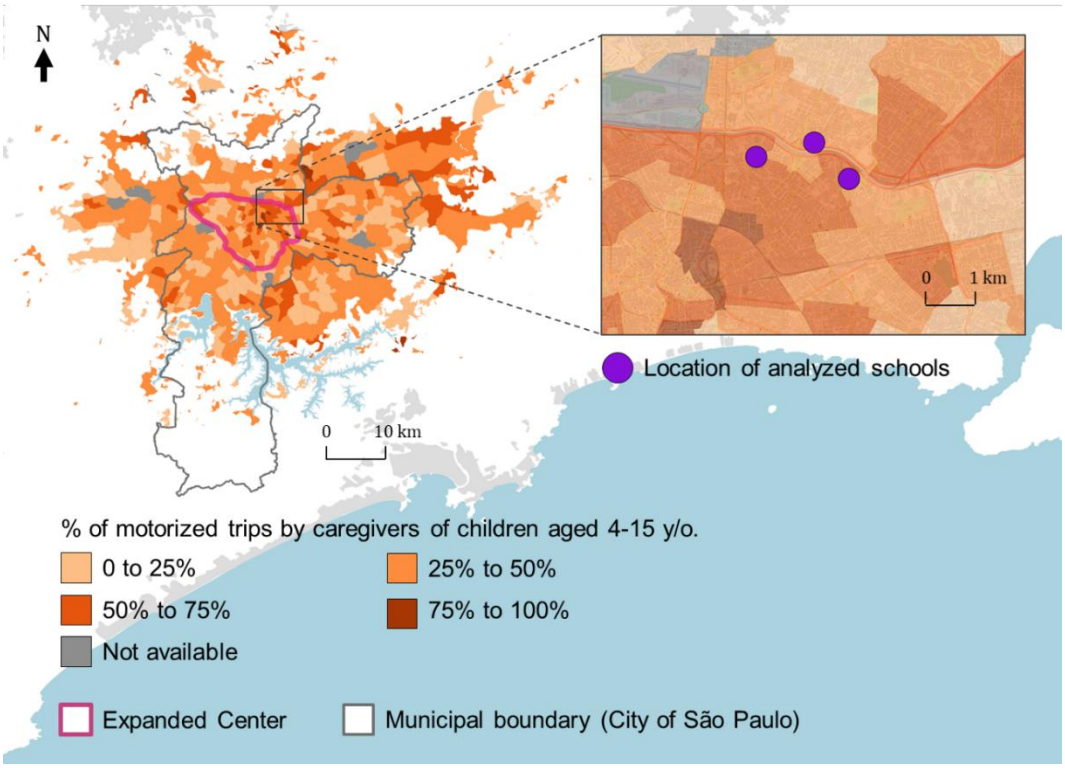


Figure 39: Context of analyzed schools in Metropolitan São Paulo regarding the share of motorized trips (car or motorcycle, all purposes) of caregivers of preschoolers and primary school-aged children (aged 4-15 y/o.). Adapted from CET (2013), GeoSampa (2018), IBGE (2005), and METRÔ-SP (2018).

Appendix B: Questionnaires to Caregivers

T1 (pre), in Portuguese

Estudo da influência do ambiente construído na mobilidade de crianças em São Paulo

1) Qual a sua **idade?** ☐

2) Qual o seu **gênero?**

○ Mulher
○ Homem
○ Outro

3) Quantas pessoas moram em sua casa?

Preencher com **número**:

☐ Crianças pequenas (0 a 12 anos)
☐ Crianças (13 a 19 anos)
☐ Adultos (20 a 64 anos)
☐ Adultos (mais de 65 anos)

4) Localização da **residência**:

_____

5) Localização do **trabalho**:

_____

6) Quais os **meios de transporte** que **você** (pai, mãe ou responsável) mais usa no seu dia-a-dia?

Possível marcar **mais de uma** opção:

☐ A pé/caminhada;
☐ Carro;
☐ Ônibus;
☐ Bicicleta;
☐ Metrô;
☐ Trem;
☐ Moto;
☐ Outro (indicar): _____

7) Com quem **seu filho** costuma vir para a escola?

Possível marcar **mais de uma** opção:

☐ Sozinho (a)
☐ Com pai/padrasto
☐ Com mãe/madrasta
☐ Com avó/avô;
☐ Com vizinha (o);
☐ Com tia/tio;
☐ Com irmã/irmão;
☐ Com cuidador (a);
☐ Com outra pessoa (indicar): _____

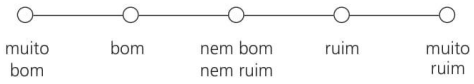
8) Quais os **meios de transporte** que **seu filho** mais usa para ir à escola?

Possível marcar **mais de uma** opção:

☐ A pé/caminhada;
☐ Transporte escolar gratuito (TEG);
☐ Transporte escolar pago;
☐ Carro;
☐ Ônibus;
☐ Bicicleta;
☐ Metrô;
☐ Trem;
☐ Moto;
☐ Outro (indicar): _____

9) Na minha opinião, os outros pais acham que ir a pé para a escola é:

Marcar **só uma** opção:



10) As crianças desta escola costumam vir a pé:

Marcar **só uma** opção:

11) Você gostaria de comentar alguma coisa sobre o caminho de seu filho até a escola (qualidade das calçadas, arborização, acidentes de trânsito, iluminação etc.)?

_____
_____
_____
_____
_____
_____

* Os dados coletados serão anonimizados e usados exclusivamente para fins científicos

T2 (post), in Portuguese

Estudo da influência do ambiente construído na mobilidade de crianças em São Paulo: 2º Questionário para as famílias

1) Qual o nome do **seu filho/sua filha?**

_____

2) Quais os **meios de transporte** que **você** (pai, mãe ou responsável) mais usa no seu dia-a-dia?

Possível marcar **mais de uma** opção:

☐ A pé/caminhada;
☐ Carro;
☐ Ônibus;
☐ Bicicleta;
☐ Metrô;
☐ Trem;
☐ Moto;
☐ Outro (indicar): _____

3) Com quem seu filho costuma vir para a escola?

Possível marcar **mais de uma** opção:

☐ Sozinho (a);
☐ Com pai/padrasto;
☐ Com mãe/madrasta;
☐ Com avó/avô;
☐ Com vizinha (o);
☐ Com tia/tio;
☐ Com irmã/irmão;
☐ Com cuidador (a);
☐ Com outra pessoa (indicar): _____

4) Quais os **meios de transporte** que **seu filho** mais usa para ir à escola?

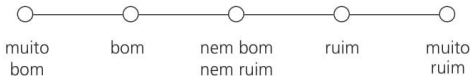
Possível marcar **mais de uma** opção:

☐ A pé/caminhada;
☐ Transporte escolar gratuito (TEG);
☐ Transporte escolar pago;
☐ Carro;
☐ Ônibus;
☐ Bicicleta;
☐ Metrô;
☐ Trem;
☐ Moto;
☐ Outro (indicar): _____

* Os dados coletados serão anonimizados e usados exclusivamente para fins científicos

5) Na sua opinião, os pais das outras crianças acham que ir a pé para a escola é:

Marcar **só uma** opção:



6) Na sua opinião, as outras crianças desta escola costumam vir a pé:

Marcar **só uma** opção:

7) Desde o começo do semestre, você acha que seu filho comentou mais dos espaços abertos perto da sua casa e da escola (ruas, praças, calçadas, parques etc.)?

Marcar **só uma** opção:

8) Você gostaria de fazer algum comentário sobre o projeto que fizemos com a turma do seu filho neste semestre?

_____
_____
_____
_____
_____
_____

9) Caso tenha interesse em ser informado das análises e resultados do projeto, favor indicar Whatsapp ou e-mail:

_____

T2 (post), in Spanish

Estudio de la influencia del ambiente contruido en la movilidad
de los niños y niñas en São Paulo: 2ª Encuesta para las familias

1) ¿Cuál es el nombre de **su hijo/hija**?

_____

2) ¿Cuáles son **los medios de transporte** que **usted** (padre, madre o responsable) más usa en su día a día?

Es posible marcar **más de una** opción:

☐ Caminando;
☐ Carro;
☐ Autobus;
☐ Bicicleta;
☐ Metro;
☐ Tren;
☐ Moto;
☐ Otro (indicar): _____

3) ¿Con quién su hijo(a) acostumbra venir a la escuela?

Es posible marcar **más de una** opción:

☐ Solo(a);
☐ Con su padre/padrasto;
☐ Con su madre/madrasta;
☐ Con su abuelo(a);
☐ Con el vecino(a);
☐ Con su tía/tío;
☐ Con su hermano(a);
☐ Con la persona que lo cuida;
☐ Con otra persona (indicar): _____

4) ¿Cuáles son **los medios de transporte** que **su hijo(a)** más usa para ir a la escuela?

Es posible marcar **más de una** opción:

☐ Caminando;
☐ Transporte escolar gratuito (TEG);
☐ Transporte escolar pago;
☐ Carro;
☐ Autobus;
☐ Bicicleta;
☐ Metro;
☐ Tren;
☐ Moto;
☐ Otro (indicar): _____

* Los datos serán anonimizados y utilizados exclusivamente con fines científicos

5) En su opinión, los padres de los otros niños y niñas creen que ir caminando para la escuela es:

Marcar **sólo una** opción:

6) En su opinión, los otros niños y niñas de esta escuela acostumbran venir caminando:

Marcar **sólo una** opción:

7) Desde el comienzo del semestre, usted cree que su hijo(a) comentó más de los espacios abiertos cerca de su casa y de la escuela (calle, plazas, aceras, parques, etc.)?

Marcar **sólo una** opción:

8) ¿A usted le gustaría hacer algún comentário sobre el proyecto que hicimos con el grupo de su hijo(a) en este semestre?

_____
_____
_____
_____
_____
_____

9) En caso de interés de ser informado de los análisis y resultados del proyecto, por favor coloque su Whatsapp o e-mail:

_____

T3 (follow-up), in Portuguese

Version 1 (for respondents of questionnaire T1)

Estudo da influência do ambiente construído na mobilidade de crianças em São Paulo: 3º Questionário para as famílias

1) Quais os **meios de transporte** que **você** (pai, mãe ou responsável) mais usa no seu dia-a-dia?

Possível marcar **mais de uma** opção:

☐ A pé/caminhada;
☐ Carro;
☐ Ônibus;
☐ Bicicleta;
☐ Metrô;
☐ Trem;
☐ Moto;
☐ Outro (indicar): _____

2) Quais os **meios de transporte** que **seu filho** mais usa para ir à escola?

Possível marcar **mais de uma** opção:

☐ A pé/caminhada;
☐ Transporte escolar gratuito (TEG);
☐ Transporte escolar pago;
☐ Carro;
☐ Ônibus;
☐ Bicicleta;
☐ Metrô;
☐ Trem;
☐ Moto;
☐ Outro (indicar): _____

3) Na sua opinião, os pais das outras crianças acham que ir a pé para a escola é:

Marcar **só uma** opção:

4) Na sua opinião, as outras crianças desta escola costumam vir a pé:

Marcar **só uma** opção:

5) O que contribuiria para que você e o seu filho fossem mais vezes a pé para a escola e da escola para casa?

Possível marcar **mais de uma** opção:

☐ Calçadas em bom estado;
☐ Boa iluminação das ruas e calçadas;
☐ Distância menor entre casa e escola;
☐ Companhia e apoio de pais de outras crianças;
☐ Mais comércio nas calçadas;
☐ Policiamento nas ruas;
☐ Pessoas conhecidas passando nas calçadas;
☐ Espaços de lazer no caminho (praças, parques);
☐ Menos carros, caminhões e motos nas ruas;
☐ Horários de trabalho mais flexíveis;
☐ Não existir outra alternativa de transporte.

Se quiser comentar as opções escolhidas e escrever outras razões além das apresentadas acima, pode registrar aqui.

_____

_____

_____

_____

_____

_____

_____

6) Caso tenha interesse em ser informado dos resultados do projeto, e ainda não tenha deixado o seu contato conosco, favor indicar Whatsapp ou e-mail:

_____

* Os dados coletados serão anonimizados e usados exclusivamente para fins científicos

Version 2 (for non-respondents of questionnaire T1)

Estudo da influência do ambiente construído na mobilidade de crianças em São Paulo: 3º Questionário para as famílias

1) Qual a sua **idade?** ☐

2) Quantas pessoas moram em sua casa?

Preencher com **número** de pessoas em cada grupo:

☐	Crianças pequenas (0 a 12 anos)
☐	Jovens (13 a 19 anos)
☐	Adultos (20 a 64 anos)
☐	Idosos (mais de 65 anos)

3) Localização da **residência**:

_____

4) Localização do **trabalho**:

_____

5) Quais os **meios de transporte** que **você** (pai, mãe ou responsável) mais usa no seu dia-a-dia?

Possível marcar **mais de uma** opção:

☐ A pé/caminhada;
☐ Carro;
☐ Ônibus;
☐ Bicicleta;
☐ Metrô;
☐ Trem;
☐ Moto;
☐ Outro (indicar): _____

6) Quais os **meios de transporte** que **seu filho** mais usa para ir à escola?

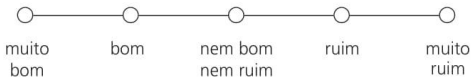
Possível marcar **mais de uma** opção:

☐ A pé/caminhada;
☐ Transporte escolar gratuito (TEG);
☐ Transporte escolar pago;
☐ Carro;
☐ Ônibus;
☐ Bicicleta;
☐ Metrô;
☐ Trem;
☐ Moto;
☐ Outro (indicar): _____

* Os dados coletados serão anonimizados e usados exclusivamente para fins científicos

7) Na sua opinião, os outros pais acham que ir a pé para a escola é:

Marcar **só uma** opção:



8) Na sua opinião, as outras crianças desta escola costumam vir a pé:

Marcar **só uma** opção:

9) O que contribuiria para que você e o seu filho fossem mais vezes a pé para a escola e da escola para casa?

Possível marcar **mais de uma** opção:

☐ Calçadas em bom estado;
☐ Pessoas conhecidas passando nas calçadas;
☐ Mais comércio nas calçadas;
☐ Policiamento nas ruas;
☐ Menos carros, caminhões e motos nas ruas;
☐ Boa iluminação das ruas e calçadas;
☐ Não existir outra alternativa de transporte;
☐ Espaços de lazer no caminho (praças, parques);
☐ Distância menor entre casa e escola;
☐ Horários de trabalho mais flexíveis;
☐ Companhia e apoio de pais de outras crianças.

Se quiser comentar as opções escolhidas e escrever outras razões além das apresentadas acima, pode registrar aqui.

_____

_____

_____

_____

_____

_____

10) Caso tenha interesse em ser informado dos resultados do projeto, favor indicar Whatsapp ou e-mail:

_____

T3 (follow-up), in Spanish

Version 1 (for respondents of questionnaire T1)

Estudio de la influencia del ambiente contruido en la movilidad de los niños y niñas en São Paulo: 3ª Encuesta para las familias

1) Cuáles son **los medios de transporte** que **usted** (padre, madre o responsable) más usa en su día a día?

Es posible marcar **más de una** opción:

☐ Caminando;
☐ Carro;
☐ Autobus;
☐ Bicicleta;
☐ Metro;
☐ Tren;
☐ Moto;
☐ Otro (indicar): _____

2) ¿Cuáles son **los medios de transporte** que **su hijo(a)** más usa para ir a la escuela?

Es posible marcar **más de una** opción:

☐ Caminando;
☐ Transporte escolar gratuito (TEG);
☐ Transporte escolar pago;
☐ Carro;
☐ Autobus;
☐ Bicicleta;
☐ Metro;
☐ Tren;
☐ Moto;
☐ Otro (indicar): _____

3) En su opinión, los padres de los otros niños y niñas creen que ir caminando para la escuela es:

Marcar **sólo una** opción:

4) En su opinión, los otros niños y niñas de esta escuela acostumbran venir caminando:

Marcar **sólo una** opción:

5) ¿Qué les ayudaría a usted y a su hijo/a para que fuesen caminando a la escuela y desde la escuela a la casa con más frecuencia?

Es posible marcar **más de una** opción:

☐ Distancia menor entre la casa y la escuela;
☐ Más comercio en la acera;
☐ Buena iluminición de las calles y acera;
☐ Menos carros, camiones y motocicletas en las calles;
☐ Aceras en buenas condiciones;
☐ Espacios recreativos en el camino (plazas, parques);
☐ Más gente conocida caminando por las aceras;
☐ Presencia policial en las calles;
☐ Horarios de trabajo más flexibles;
☐ No tener otra alternativa de transporte;
☐ Compañía y soporte de los padres de los otros niños.

Si desea comentar sobre las opciones que ha elegido y escribir otras razones distintas a las anteriores, puede escribir aquí:

_____
_____
_____
_____
_____
_____
_____

6) En caso de interés de ser informado de los análisis y resultados del proyecto, por favor coloque su Whatsapp o e-mail:

_____

* Los datos serán anonimizados y utilizados exclusivamente con fines científicos

Version 2 (for non-respondents of questionnaire T1)

Estudio de la influencia del ambiente contruido en la movilidad de los niños y niñas en São Paulo: 3ª Encuesta para

1) ¿Cuál es **su edad**? ☐

2) ¿Cuántas personas viven en su casa?

Complete con **el número** de personas de cada grupo:

☐	Niños pequeños (0 a 12 años)
☐	Jóvenes (13 a 19 años)
☐	Adultos (20 a 64 años)
☐	Personas mayores (más de 65 años)

3) Ubicación del local de **residencia**:

_____

4) Ubicación del local de **trabajo**:

_____

5) Cuáles son **los medios de transporte** que **usted** (padre, madre o responsable) más usa en su día a día?

Es posible marcar **más de una** opción:

☐ Caminando;
☐ Carro;
☐ Autobus;
☐ Bicicleta;
☐ Metro;
☐ Tren;
☐ Moto;
☐ Otro (indicar): _____

6) ¿Cuáles son **los medios de transporte** que **su hijo(a)** más usa para ir a la escuela?

Es posible marcar **más de una** opción:

☐ Caminando;
☐ Transporte escolar gratuito (TEG);
☐ Transporte escolar pago;
☐ Carro;
☐ Autobus;
☐ Bicicleta;
☐ Metro;
☐ Tren;
☐ Moto;
☐ Otro (indicar): _____

* Los datos serán anonimizados y utilizados exclusivamente con fines científicos

7) En su opinión, los padres de los otros niños y niñas creen que ir caminando para la escuela es:

Marcar **sólo una** opción:

8) En su opinión, los otros niños y niñas de esta escuela acostumbran venir caminando:

Marcar **sólo una** opción:

9) ¿Qué les ayudaría a usted y a su hijo/a para que fuesen caminando a la escuela y desde la escuela a la casa con más frecuencia?

Es posible marcar **más de una** opción:

☐ Menos carros, camiones y motocicletas en las calles;
☐ Horarios de trabajo más flexibles;
☐ No tener otra alternativa de transporte;
☐ Distancia menor entre la casa y la escuela;
☐ Compañía y soporte de los padres de los otros niños;
☐ Más comercio en la acera;
☐ Más gente conocida caminando por las aceras;
☐ Espacios recreativos en el camino (plazas, parques);
☐ Presencia policial en las calles;
☐ Buena iluminición de las calles y acera;
☐ Aceras en buenas condiciones.

Si desea comentar sobre las opciones que ha elegido y escribir otras razones distintas a las anteriores, puede escribir aquí:

_____

_____

_____

_____

_____

10) En caso de interés de ser informado de los análisis y resultados del proyecto, por favor coloque su Whatsapp o e-mail:

_____

Appendix C: Approval by Research Ethics Committee and Department of Education

Research Ethics Committee approval (in Portuguese)

USP- INSTITUTO DE PSICOLOGIA DA UNIVERSIDADE DE SÃO

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: ESCOLAS: EStudo da influência do ambiente COnstruído na mobiLidade de criançAs em São Paulo

Pesquisador: MATEUS HUMBERTO ANDRADE

Área Temática:

Versão: 1

CAAE: 03318918.0.0000.5561

Instituição Proponente: UNIVERSIDADE DE SAO PAULO

Patrocinador Principal: UNIVERSIDADE DE SAO PAULO

DADOS DO PARECER

Número do Parecer: 3.092.675

Apresentação do Projeto:

O projeto aqui proposto busca discutir o acesso à escola por meio dos transportes, com foco na mobilidade sustentável e na interação das crianças

com seus pais e responsáveis. Para isso, pretende avaliar as percepções sobre as formas de acessar as escolas de educação infantil (EMEIs) da cidade de São Paulo de forma quantitativa e qualitativa. A abordagem quantitativa dar-se-á sobretudo por meio do geoprocessamento, da análise de dados secundários referentes às escolas e de técnicas de modelagem estatística. A pesquisa qualitativa será de caráter exploratório, em que serão

aplicados questionários aos pais/responsáveis e sessões de questionamento abertos às crianças em escolas selecionadas para se debater a influência do entorno das escolas na mobilidade sustentável. Uma vez reunidos, os dados qualitativos poderão ter sua avaliação estratificada em grupos definidos de acordo com as análises quantitativas.

Com isso, pretende-se acompanhar a influência de abordagens participativas de pesquisa na identificação de fatores que parecem influenciar a mobilidade urbana de crianças. Além disso, busca avaliar a adequação de técnicas de geoprocessamento e de modelagem estatística juntamente à aplicação a abordagens qualitativas junto a crianças em fase pré-escolar.

Objetivo da Pesquisa:

Avaliar a influência do entorno de pré-escolas em São Paulo nas percepções de crianças e de seus

Endereço: Av. Prof. Mello Moraes,1721 - Bl. "G" sala 27
Bairro: Cidade Universitária **CEP:** 05.508-030
UF: SP **Município:** SAO PAULO
Telefone: (11)3091-4182 **E-mail:** comite.etica.ipusp@gmail.com

pais/responsáveis em relação à mobilidade urbana.

Avaliação dos Riscos e Benefícios:

Conforme o pesquisador,

"Riscos:

As atividades propostas (questionários aos pais/responsáveis e sessões de questionamento aberto a crianças) possuem risco de grau mínimo, devido à possibilidade mínima de constrangimento, desconforto e cansaço ao responder às perguntas do questionário (para pais e/ou responsáveis) e ao participar das sessões de questionamento aberto (para crianças). As atividades propostas junto a crianças seguem práticas pedagógicas em

que a não só a anuência como também a participação das crianças constituem um elemento fundamental.

Para proteger a identidade dos participantes, os questionários aos pais/responsáveis serão marcados com um código, um para cada pai/responsável. Na semana anterior ao começo das atividades propostas (questionários aos pais/responsáveis e das sessões de questionamento aberto a crianças), será pedido à professora/professor de cada turma selecionada que faça uma lista atribuindo a cada pai/responsável um código.

Em seguida, será entregue aos pais/responsáveis o questionário com o código correspondente. Quando os pais/responsáveis preencherem o questionário, este será entregue na secretaria da escola e será entregue diretamente ao pesquisador principal. Dessa forma, pretendemos assegurar que a identidade dos participantes se mantém anônima, bem como as suas respostas ao questionário. O pesquisador não tem acesso às

informações que permitam fazer qualquer tipo de identificação e as professoras/professores das turmas selecionadas não têm contato com os

questionários dos pais/responsáveis. De forma similar, as folhas de registro das sessões de questionamento aberto a crianças contarão com códigos

para assegurar que as identidades e declarações das crianças se mantenham anônimas.

Além disso, a solicitação do código postal ao invés do endereço para localizar a residência e o trabalho dos participantes da pesquisa também serve

para garantir a anonimização dos participantes da pesquisa, já que o código postal fornece uma localização estimada do endereço da pessoa e torna impossível o conhecimento do endereço exato (por ex. número da residência, andar ou apartamento) de qualquer participante da pesquisa.

Benefícios:

Contribuição para a compreensão de dois fenômenos que impactam diretamente o cotidiano das

escolas, ou seja, as percepções sobre as formas de acessar as escolas (caminhar, pedalar, cruzar uma praça, esperar no ponto de ônibus, receber carona etc.) e as condições objetivas de acesso às escolas (sobretudo por meio de dados secundários e do geoprocessamento). Os métodos e produtos decorrentes deste projeto podem ainda ser
úteis para a análise de condições de acessibilidade a outros serviços fundamentais como o acesso aos serviços de saúde. Também, serão organizadas sessões de esclarecimento da pesquisa e de apresentação dos resultados aos participantes da pesquisa (crianças, pais e responsáveis, direção da escola e corpo docente) de forma a garantir o retorno social para os participantes da pesquisa."

Comentários e Considerações sobre a Pesquisa:

Nº de participantes da pesquisa: 300

ID Grupo - Nº de Indivíduos - Intervenções a serem realizadas
Pais e/ou responsáveis - 150 - Questionários aos pais/responsáveis
Crianças (alunos EMEIs selecionadas) - 150 - Sessões de questionamento aberto às crianças

Critério de Inclusão:
O critério de seleção das escolas é baseado num indicador de mobilidade potencial (mobility capabilities), elaborado sob a ótica da Abordagem das
Capacidades (Capability Approach), que busca “avaliar as conquistas e liberdades de uma pessoa em termos de sua habilidade real para exercer diferentes coisas que ela valoriza” (SEN, 1979; NUSSBAUM, 2007). Esse indicador leva em consideração a agregação de três temas em um único indicador: i) a rede viária, que inclui a conectividade da rede viária na área circundante da escola e a centralidade da localização da escola na rede
viária urbana; ii) a segurança no trânsito, ou seja, a taxa de acidentes envolvendo carros e pedestres durante períodos de chegada e saída das escolas; e iii) a qualidade do ambiente construído no entorno das escolas, que se refere à densidade populacional, à vulnerabilidade social, à concentração de crianças em idade pré-escolar, à distribuição de renda, entre outros atributos. Para maiores detalhes sobre o indicador de mobilidade potencial para acessar escolas conferir o trabalho de Humberto et al. (2018).
Em seguida, serão pré-selecionadas 15 escolas de diferentes níveis de mobilidade potencial, de que resultará a seleção final de quatro escolas, avaliadas de acordo com a disposição da direção da escola e do corpo docente para implantar as atividades educativas propostas (sessões de questionamento aberto a crianças). Seguindo o mesmo critério, serão selecionadas duas turmas

em cada escola, totalizando
oito turmas nas quatro escolas selecionadas.
Critério de Exclusão:
De forma similar aos critérios de inclusão apresentados, não serão consideradas neste estudo as escolas cujos níveis de mobilidade potencial (rede viária, segurança viária e ambiente construído) estejam fora do padrão apresentado pelas demais escolas (outliers). Ainda referente às escolas, também serão excluídas as escolas pré-selecionadas cuja direção da escola e/ou corpo docente não estejam dispostos a implantar as atividades
educativas propostas (sessões de questionamento aberto a crianças). Da mesma forma, o estudo não será implantado nas turmas em que as crianças não estejam interessadas em participar das atividades educativas propostas.

Considerações sobre os Termos de apresentação obrigatória:
O pesquisador informa no TCLE que "Para tanto, gostaria que você participasse desta pesquisa, na qual me comprometo a seguir as Resoluções CNS nº 466 de 2012 (relacionada à Pesquisa com Seres Humanos) e CNS nº 510 de 2016 (que dispõe sobre as Normas aplicáveis a pesquisas em Ciências Humanas e Sociais), garantindo o seu direito de:".
Apesar do pesquisador afirmar no TCLE que "Asseguramos que as atividades propostas possuem uma possibilidade mínima de constrangimento, desconforto ou cansaço devido à participação nas sessões de questionamento aberto e ao preenchimento dos questionários.", não é informado ao participante o oferecimento de atendimento e/ou encaminhamento psicológico se necessário.
O pesquisador informa no TCLE os números de telefone fixo, endereços e emails na USP do pesquisador e da orientadora, mas não informa os respectivos do CEPH-IPUSP.
O TALE está redigido na terceira pessoa do plural: "Os pais de vocês já concordaram em participar dessa pesquisa, mas eu também gostaria de saber se poderia contar com o apoio de vocês."

Conclusões ou Pendências e Lista de Inadequações:
O projeto está aprovado tendo o pesquisador que realizar as três modificações no TCLE apresentadas abaixo, sendo que estas devem ser comunicadas ao CEPH por meio de notificação na Plataforma Brasil.
1. A menção à Resolução CNS nº 510 de 2016 deve ser retirada do TCLE.
2. Informar no TCLE que ao participante haverá o oferecimento de atendimento psicológico se necessário.

3. Informa no TCLE o número de telefone fixo, endereço e email do CEPH-IP.

4. O texto do TALE deve dirigir-se a cada criança em particular e não ao grupo.

Considerações Finais a critério do CEP:

Considerações finais a critério do CEP:

Diante do exposto, o Comitê de Ética em Pesquisa com Seres Humanos, de acordo com as atribuições definidas na Resolução CNS nº 510 de 2016, na Resolução CNS nº 466 de 2012 e na Norma Operacional nº 001 de 2013 do CNS, manifesta-se pela aprovação do projeto de pesquisa proposto.

Situação: Protocolo aprovado.

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_1248368.pdf	05/11/2018 19:59:35		Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	termo_consentimento.pdf	05/11/2018 19:54:25	MATEUS HUMBERTO ANDRADE	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	termo_assentimento.pdf	05/11/2018 19:54:15	MATEUS HUMBERTO ANDRADE	Aceito
Outros	quest_pais_modelo.docx	05/11/2018 19:54:03	MATEUS HUMBERTO ANDRADE	Aceito
Outros	solicitacao_analise_ceph_ipusp.pdf	05/11/2018 19:53:35	MATEUS HUMBERTO ANDRADE	Aceito
Projeto Detalhado / Brochura Investigador	projeto_detalhado.pdf	05/11/2018 19:52:42	MATEUS HUMBERTO ANDRADE	Aceito
Declaração do Patrocinador	declaracao_patrocinador.pdf	05/11/2018 19:17:21	MATEUS HUMBERTO ANDRADE	Aceito
Declaração de Pesquisadores	declaracao_pesquisador.pdf	05/11/2018 19:17:09	MATEUS HUMBERTO ANDRADE	Aceito
Declaração de Instituição e	declaracao_infra.pdf	05/11/2018 19:16:57	MATEUS HUMBERTO	Aceito

Infraestrutura	declaracao_infra.pdf	05/11/2018 19:16:57	ANDRADE	Aceito
Folha de Rosto	folha_rosto.pdf	05/11/2018 19:16:49	MATEUS HUMBERTO ANDRADE	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

SAO PAULO, 18 de Dezembro de 2018

Assinado por:
Jose de Oliveira Siqueira
(Coordenador(a))

Endereço: Av. Prof. Mello Moraes,1721 - Bl. "G" sala 27
Bairro: Cidade Universitária **CEP:** 05.508-030
UF: SP **Município:** SAO PAULO
Telefone: (11)3091-4182 **E-mail:** comite.etica.ipusp@gmail.com

Department of Education approval, schools 1 and 2 (in Portuguese)

Gmail **Mateus Humberto <mateushumberto@gmail.com>**

ENC: Autorização pesquisa escolas DRE Penha

SME - DRE Penha - ADM <smedrepenhaadm@sme.prefeitura.sp.gov.br> 4 de fevereiro de 2019 16:31
Para: "EMEI - ELDY POLI BIFONE - PROFA." <emeiepbifone@prefeitura.sp.gov.br>, EMEI - CASPER LIBERO <emeiclibero@prefeitura.sp.gov.br>
Cc: "mateushumberto@usp.br" <mateushumberto@usp.br>

À

EMEI Profª Eldy Poli Bifone

EMEI Cásper Líbero

Srs. Diretores

Após análise da solicitação inicial e por estar de acordo com o memorando circular nº 003/2017 – SME-G, autorizamos a realização da pesquisa intitulada "**Estudo da influência do ambiente construído na mobilidade de crianças em São Paulo**".

Ressaltamos que as orientações emitidas pelos Supervisores Escolares de ambas as unidades deverão ser rigorosamente atendidas.

Atenciosamente,

PREFEITURA DE SÃO PAULO EDUCAÇÃO

Luci Batista Costa S. de Miranda
Diretor Regional de Educação
Diretoria Regional de Educação Penha
☎ 3397-9162 ✉ lbmiranda@sme.prefeitura.sp.gov.br
http://www.portalsme.prefeitura.sp.gov.br

Senhora Diretora Regional de Educação

A presente solicitação referente à autorização para pesquisa acadêmica do aluno de doutorado Sr. Mateus Humberto Andrade da Escola Politénica da USP foi devidamente analisada por nós, supervisores Ailton Carlos Santos e Simone Hernandez Barros, respectivos supervisores das EMEI Casper Líbero e Prof. Eldy Poli Bifone. Analisada a documentação entregue, manifestamo-nos favoráveis à realização da pesquisa nos seguintes termos:

a) a duração da pesquisa deverá ser acordada com as equipes gestoras da unidades envolvidas uma vez que encontramos diferentes períodos de realização no ano de 2019 na documentação analisada;

b) todos os procedimentos para pesquisa in loco deverão ter autorização e ciência da equipe gestora, funcionários, pais/responsáveis e professores;

c) observar e atender as conclusões ou pendências e lista de inadequações constantes no parecer consubstanciado do CEP;

d) na hipótese de divulgação da pesquisa em publicações (livros, revistas, sites, etc) o referido texto deverá ser objeto de prévia autorização da SME e, quando finalizado o trabalho, uma cópia deverá ser encaminhada à UE envolvida e à DRE.

Salientamos que caberá ao diretor da unidade educacional a indicação de um funcionário para acompanhamento do pesquisador durante seu trabalho, visando ao fiel cumprimento da pesquisa.

À consideração superior

Ailton Carlos Santos	Simone Hernandez Barros
RF 6783872/1	RF 6908021/2
Supervisor Escolar	Supervisora Escolar

De: Crislaine Aparecida Francisco [mailto:crislainefrancisco@sme.prefeitura.sp.gov.br]
Enviada em: sexta-feira, 1 de fevereiro de 2019 15:39
Para: Ailton Carlos Santos
Assunto: ENC: Autorização pesquisa escolas DRE Penha

Prezado Supervisor Ailton,

Encaminhamos a solicitação de pesquisa acadêmica, para análise e manifestação.

Atenciosamente,

PREFEITURA DE SÃO PAULO
EDUCAÇÃO

Crislaine Aparecida Francisco
Supervisor Técnico II
Diretoria Regional de Educação Penha
☎ 3397-9157 ✉ crislainefrancisco@sme.prefeitura.sp.gov.br
http://www.portalsme.prefeitura.sp.gov.br

Department of Education approval, school 3 (in Portuguese)

PREFEITURA DE SÃO PAULO
EDUCAÇÃO

DRE JT
DIRETORIA REGIONAL DE EDUCAÇÃO JAÇANÃ TREMEMBÉ

Diretoria Regional de Educação Jaçanã Tremembé

PARECER – FEVEREIRO 2019

Interessado: **Mateus Humberto Andrade**
Assunto: SOLICITAÇÃO DE AUTORIZAÇÃO PARA A REALIZAÇÃO DE PESQUISA ACADÊMICA EM DUAS UNIDADES EDUCACIONAIS DA DIRETORIA DE EDUCAÇÃO JAÇANÃ TREMEMBÉ

Trata-se o presente de solicitação de autorização da Sr. **Mateus Humberto Andrade** para realização de pesquisa acadêmica nas Unidades Educacionais **EMEI Professor Pedro Alvares Cabral Moraes e EMEI José Bonifácio de Andrada e Silva,** pertencente à Diretoria Regional de Educação Jaçanã Tremembé no período **fevereiro e agosto de 2019** com a abordagem do projeto de pesquisa : **"Estudo da influência do ambiente construído na mobilidade de crianças em São Paulo (ESCOLAS)",** vinculado à Escola Politécnica da Universidade de São Paulo- Departamento de Engenharia de Transportes.

Em análise da documentação encaminhada, que atende ao predisposto no Memorando Circular nº 003/2017/SME-G, Inciso II, consideramos que atende aos itens solicitados.

Solicitamos atenção à legislação vigente no atendimento do disposto no Artigo 2º do Decreto nº 14.353/1977 o qual transcrevemos abaixo:

> *"Ao final da realização dos estudos e pesquisas, o trabalho deles resultante será dado ao conhecimento da Secretaria Municipal de Educação, que poderá divulga-lo e utilizá-lo sempre no interesse do Ensino Municipal."*

E do Memorando Circular nº 003/2017/SME-G, que determina:

> *"III – A Utilização de registro de imagem de quaisquer espaços das UEs ou de alunos só poderá ser utilizada mediante autorização expressa da ASCOM da SME.*
>
> *IV – Na hipótese de divulgação da pesquisa em publicações (livros, revistas, sites, etc) o referido texto deverá ser objeto de prévia autorização da SME e, quando finalizando o trabalho, uma cópia deverá ser encaminhada à U.E. envolvida e à DRE. "*

Em face do exposto e considerando o atendimento ao Decreto nº 14.353/1977, de acordo com a Portaria SME nº 956/1979 e os procedimentos estabelecidos pelo Memorando Circular nº 003/2017/SME-G, emitimos parecer favorável à realização da pesquisa acadêmica dentro do prazo previsto e atendendo ao dispositivo legal e após anuência dos Diretores das Unidades Educacionais envolvida.

Patricia Fernandes Rosa
RF 752.841.8/1 RG 23.854.726.7
Diretor Regional de Educação
DRE JT / SME