PROPOSAL

to the

Center for Advancing Research in Transportation, Emissions, Energy & Health

Submitted by

Georgia Institute of Technology
Department of Civil & Environmental Engineering
North Ave NW, Atlanta, GA 30332

Title:	PM Exposure for Paratransit Transport
Estimated time of Conduct:	March 1, 2018 – Feb 28, 2019
Date Submitted:	Feb 14, 2018
Principal Investigator:	Dr. Alex Samoylov Senior Research Scientist School of Civil and Environmental Engineering Georgia Institute of Technology
Estimated Cost:	$30,000

Signed:

Principal Investigator:

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Introduction

Air pollution is often referred as invisible killer. According to the report by International Agency for Research on Cancer (IARC), outside air pollution is the leading environmental cause of chronic obstructive pulmonary disease (COPD) and cancer deaths (1). Another report by World Health Organization says that almost 94% of deaths worldwide are due to COPD, lung cancers and cardiovascular diseases (2). A total of 7 million premature deaths worldwide in 2012 were due to outdoor air pollution (3). Out of all these mentioned deaths due to outside air pollution, the number of elderly population are much larger compared to younger population. The main reason is that the chronic diseases affect elderly more than younger population (4). Air pollutants mainly contain NOx, PM, CO2, greenhouse gases, SOx and CH4. The biggest source of these emissions are vehicle emissions, particularly emissions from diesel-powered buses and trucks. Based on studies by World Health Organization Particulate Matters (PM) has been the most important factor behind increase in the number of lung cancer (2).

These PM particles travel deep into the lungs (some might enter the blood system) and cause or exacerbate heart and lung diseases. Any PM size less than 10 micrometers in size are dangerous for human health (5). The effect of PM on human health depends on age as well as pre-existing heart or lung diseases. US population is aging. Residents age 65 and over grew from 35.0 million (12.4 %) in 2000, to 49.2 million (15.2 %) in 2016 (6). The same percentage is expected to grow to 19 % by 2030 (7). Large portion of this population group has limited transportation options and must rely on services such as paratransit transport. Of course, normal transport can be used but it is quite inconvenient for elder population. Paratransit transport typically provides transportation options for seniors and individuals that cannot access the fixed route bus or rail system. Thus, the increase in senior population will lead to more trips and increased exposure to PM emissions. This is a nationwide issue. For example, Government Accountability Office reports 7 percent increase in annual paratransit trips from 2007 - 2010 (8). State of Maryland, for example, realized as much as 15% growth in annual paratransit ridership in 2012 (9). However, PM exposure during the use of paratransit services is understudied. There has been lots of recent changes in engine types for normal buses to reduce emissions- most of them have exhaust gas cleaning system, retrofits to reduce PM emissions etc. But paratransit buses are diesel driven and less studies have been carried out in the past along PM emissions from such special buses. This project will try to bridge this gap and provide valuable information for researchers and planners.

Objectives

As paratransit bus has longer stoppage to give sufficient time to elder population to enter or exit the bus. This leads to longer ingress and egress times which will further result in longer idling times and thereby increasing PM exposure inside bus cabin as well as outside waiting area. The objective of this research is to measure PM emissions from paratransit buses and study the effect of such emissions on sensitive population. This project will aim to evaluate the contribution of PM10 & PM2.5 emissions from paratransit buses in Atlanta and evaluate the health effect of such exposure on elder population. The project will further expand upon suggesting solutions to protect sensitive elderly population as well as environment. The objective of the research can be fulfilled after completing several steps which has been discussed below:

- Literature review to be carried out on emissions from diesel powered buses and trucks especially PM2.5 & PM10 emissions and exposure study along with its impact on human health. Literature focusing on emissions and exposure modelling will be studied in detail.
- Field measurement of diesel emissions from paratransit buses: As there are very less existing dataset for PM10 exposure from paratransit buses, actual field measurement will be carried out at waiting area in bus stops and inside cabin of paratransit bus. The measurement will be used to develop exposure model which will help in assessment of health impact on elder population.
- Development of elderly population exposure model: The measurement data will be used to develop a population exposure model using several statistical techniques. Moreover, health impact assessment on elder population will be carried out.
- Finding solutions and providing valuable information to researchers with similar objectives: The research study will help in predicting future impact of PM exposure and hence will provide solutions to reduce health hazards from diesel driven paratransit buses. The solutions will focus mostly on sensitive elder population as they are more prone to COPD, heart diseases etc. The measurement data will also be made available for further studies

Work Plan

Task 1

Literature review: Various related published papers and research studies will be reviewed in detail. *Deliverables: None*

Task 2

Permission to carry out measurement from paratransit buses & Analysis of paratransit bus routes: Planned measurement to be carried out on Marta Mobility paratransit buses and thus first step of work plan is to take permission from authority to carry out research. According to marts website: “MARTA Mobility is a shared ride and operate in area within Fulton, DeKalb and Clayton Counties and the City of Atlanta along a 3/4-mile corridor located on each side of all fixed bus routes and in a 3/4-mile radius of each station.” Detailed analysis of

routes for these buses to be carried out. *Deliverables: Route Plan where measurements will be carried out.*

Task 3

Field measurements: The field measurements to be done for ambient concentration of PM2.5 and PM10 during transport, pickup locations, and drive through medical facilities, food court etc. Both the data measurements of PM emissions i.e. inside and outside of the bus will be measured using the GRIMM 1.109 aerosol spectrometer with isokinetic sampling pipe. One GRIMM devise will be used to measure inside PM concentration and other device will be used simultaneously to measure outside PM concentration. In addition to GRIMM data, the vehicle will also be equipped with a temperature and humidity logger. The data for pre-existing conditions i.e. heart or lung disease of commuters on paratransit transport to be collected. *Deliverables: PM measurement data sheet.*

Task 4

Data Analysis and modelling: The measured emissions data will be analyzed statistically. Input data will be from random samples from measurement. The modeling portion will include vehicle age, location and meteorological data. AERMOD and ArcGis will be used as required. If required, regression analysis can also be used. *Deliverables: Data Analysis report and update on progress of project.*

Task 5

Final Report: Based on data analysis and statistical modelling, final report will be created. *Deliverables: Final report and recommendations based on project results.*

Significance of Research

The research is of great significance because it deals with the assessment of health impact on elderly population and focusses on PM exposure from paratransit buses which has been understudied in the past. This research study will open new chapter in this field.
Paratransit buses are different from normal buses. They have longer stoppage compared to normal buses in order to give sufficient time to elder population to enter or exit the bus. This results in longer idling times and thereby increasing PM exposure inside bus cabin as well as outside waiting area. Paratransit bus, mostly used by elderly population, is increasing in number to cater for increasing elder population. Thus, it becomes important to conduct study on paratransit bus PM exposure specifically to that sensitive population.

Deliverables

Start of project will be March 2018 and expected end of project will be Feb 2019. A final draft will be submitted around December 2018 and final report of the project will be submitted in the month of Feb 2019. Other deliverables include

- Route Plan where measurements will be carried out.
- PM measurement data sheet.
- Data Analysis report and update on progress of project.
- Final report and recommendations based on project results.

Implementation

The research modelling results will be used in predicting future impact of PM exposure on elderly population and hence, will provide solutions to reduce health hazards from diesel driven paratransit buses. The results can also be used in further future study in collaboration with medical schools like John Hopkins University.

Budget Estimate

The total project cost is $30,000.00. The project budget can be itemized in following budget categories:

Budget Estimate			
1	**Salaries and Wages**		**$29,000**
	Name	*Time in project*	*Cost*
	Dr. Alex Samoylov	1 week	$7,000
	Kumar Rajarshi	16 weeks	$22,000
2	**Materials and Supplies**		**$500**
	Aluminium Brackets		
	Fixing set for GRIMM		
	Tape etc		
3	**Travel Expense**		**Nil**
	No travelling involved		
4	**Miscellaneous**		**$500**
	Equipment Rental etc		
	Total		**$30,000**

Work Plan Schedule

The total project duration is 12 (twelve) months.

		Month											
		1	2	3	4	5	6	7	8	9	10	11	12
Task	Details	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Task 1	Literature Review												
Task 2	Analysis of paratransit bus routes												
Task 3	Field Measurement												
Task 4	Data Analysis & Modelling												
Task 5	Final Report												

Research Team Member Information

Principle Investigator:

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Dr. Samoylov is a Senior Research Scientist and he hold joint appointment between Georgia Tech's School of Civil and Environmental Engineering and Georgia Tech Research Institute's Aerospace, Transportation, and Advance Systems Laboratory
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References

1. IARC Scientific Publication No 161.
[Online] IARC, 2013. http://www.iarc.fr/en/publications/books/sp161/index.php.
2. World Health Organization. Ambient Air Pollution: A Global Assessment of Exposure and Burden of Disease.
[Online] http://apps.who.int/iris/bitstream/10665/250141/1/9789241511353-eng.pdf.
3. World Health Organization.
[Online] http://www.who.int/mediacentre/news/releases/2014/air-pollution/en/.
4. Adverse effects of outdoor pollution in the elderly, by: Marzia Simoni, Sandra Baldacci, Saa Maio, Sonia Cerrai, Giuseppe Sarno, Giovanni Viegi.
[Online] Journal of Thoracic Disease, January 2015.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4311079/.
5. United States, Environmental Protection Agency.US-EPA.
[Online] https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm.
6. United States Census Bureau, Census Bureau Reports: Release Number: CB17-100.
[Online] June 2017. https://www.census.gov/newsroom/press-releases/2017/cb17-100.html.
7. United States Census Bureau. THE NEXT FOUR DECADES; THE OLDER POPULATION IN UNITEDSTATES.
[Online] May 2010. https://www.census.gov/prod/2010pubs/p25-1138.pdf.
8. Office, United States Government Accountability. *ADA Paratransit Services.* Washington, DC: s.n. bvc , November, 2012.
9. Administration, Maryland Transit. *Analysis of the FY2014 Maryland Executive Budget.* Baltimore, MD: s.n. , 2014.
10. United States Government Accountability Office. ADA Paratransit Services. Washington, DC: s.n. , November, 2012.