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**Vehicle emission reduction**

An experimental approach for analysing  
sustainable traffic strategies

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## Summary

This is a cumulative dissertation and aims to address the research problem of the influence of current policy practices on the on-road traffic pollution abatement in the emerging megacity of Hyderabad. The dissertation is divided in total of eight chapters and consists of following papers published in peer-reviewed journals.

- [Paper 1] A comprehensive integrated framework linking vehicle emissions and traffic simulation complemented with social-institutional analysis
- [Paper 2] Congestion mitigation measure in Hyderabad
- [Paper 3] Commuters' mode choice as a coordination problem: A framed field experiment on traffic policy in Hyderabad, India

These papers elaborates on the empirical vehicle-emissions analysis carried out in representative stretches in Hyderabad, provides a background study on the problem of traffic congestion and reports on the findings of the framed field experiments developed regarding commuter travel mode choice. In addition, the current document constitutes an introduction and comprehensive discussion that details the theoretical basis, analysis and conclusion of the research findings. The aim of this adapted structure is to provide the readers with a unified notation and presentation of the research accounts.

**Chapter 2** presents the conceptual work regarding the development of a Comprehensive Integrated Framework (CIF) on which this work is based. The need for such a comprehensive framework is explained by the existing on-road traffic pollution abatement process, which highlights the importance of having an emissions inventory for emissions quantification and ensuring control over technical as well as non-technical aspects of on-road vehicle usages through control measures. Later, a section of this chapter explains the combined concept of CIF—the primary objective of this research work. The combined concept works on the comprehensive analysis of behavioural (commuters') impact on on-road vehicle emissions. This concept is based on a combination of two analytical frameworks, namely the Institutions of Sustainability (IoS) framework and the Institutional Analysis and Development (IAD) framework.

**Chapter 3** elaborates on the vehicle emissions analysis carried out in representative stretches in Hyderabad. The impacts of the existing traffic strategies in Hyderabad are initially analysed in this chapter. It is followed by the extensive literature on various vehicle emission models. This chapter explains the method for vehicle emissions estimation, and presents the result as

well as analysis of on-road traffic sources of vehicle emissions from the policy perspectives.

**Chapter 4** provides a background study on the problem of traffic congestion in Hyderabad. The problem of how traffic congestion causes additional vehicle emissions in Hyderabad is initially analysed. This is followed with determining the micro and macro-level factors that leads to congestion. Additionally, this chapter provides an overview of potential congestion-abatement and demand-based non-technical measures that have been implemented at the global level. This is followed by a hypothetical analysis of those measures by exploring their pros and cons for the purpose of using them in Hyderabad. This chapter plays a significant role in understanding how the implications of commuter behaviour could form a prerequisite for successful implementation of the demand-based traffic measures. This leads to further research through analysing the problem of the commuter's travel mode choices in Hyderabad.

**Chapter 5** lays the theoretical basis of an experimental model regarding the commuter's travel mode choice in Hyderabad and its subsequent development. This chapter presents the understanding of the commuter's mode of choice during traffic congestion as coordination problem as against the general assumption in the literature as social dilemma. Additionally, this chapter provides a literature review of the existing congestion models that focus on analysing coordination problems. Complementing the research argument, a game theory perspective of urban traffic flow is presented. This perspective identifies the distinction between the collaboration and coordination problems among commuters. This theoretical diagnosis identifies variables for developing the experimental model for analysing commuter preferences between private and public modes of transport. This chapter also discusses the importance of demand-based measures in framing a coordinated strategy between private and public transport. Based on theoretical diagnosis and institutional discussions, two hypotheses regarding the effectiveness of three significant demand-based non-technical measures for the commuter's travel mode preferences are framed.

**Chapter 6** reports the results and analysis of the framed field experiment conducted in Hyderabad. The experiment is aimed to investigate the behavioural response of commuters to demand-based non-technical measures. The experiment models their travel mode choice as a coordination problem by drawing on a sample of 204 white-collared commuters from Hyderabad. The socio-demographic determinants and treatment effects of the participants concerning their mode choice are then analysed in relation to the two hypotheses i.e. how the bus subsidies, increased parking cost and public information on preferential car use can affect mode choice.

**Chapter 7** explores commuter acceptance of traffic measures through a post-experiment questionnaire in Hyderabad. The theoretical analysis of commuter

behaviour and attitude is performed using two attitude theories: Theory of Planned Behaviour (TPB) and Theory of Cognitive Dissonance (TCD). This is followed by a brief literature review regarding the psychological relevance of commuter acceptance. The empirical analysis is performed using the post-experiment questionnaire data to understand the commuter's perception of traffic problems in Hyderabad. The analysis also evaluates the public bus service and perceives the effectiveness of traffic measures in Hyderabad.

**Chapter 8** summarizes the key research findings, and presents theory as well as policy implications. The key findings from vehicle emissions estimation analysis, experimental analysis, and post-experiment questionnaire analysis of commuter mode choice are synthesized. Based on such findings, the theoretical implications concerning commuter behaviour in urban traffic, as well as policy implications and suggestions for improving emission reduction strategies have been presented. By drawing the findings together, in terms of theoretical and policy implications, this chapter revisits the road traffic pollution abatement process which highlights the overall contribution of this research work.