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# Autonomous Shared Mobility-On-Demand: Melbourne Pilot Simulation Study

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**Abstract**

This paper presents results from a simulation-based study which aimed to demonstrate the feasibility of using agent-based simulation tools to model the impacts of shared autonomous vehicles. First, the paper outlines a research framework for the development and evaluation of low carbon mobility solutions driven by two disruptive forces which are changing the mobility landscape and providing consumers with more choices to meet their transport needs: automated self-driving and on-demand shared mobility services. The focus of this paper is on development of rigorous models for understanding the demand for travel in the age of connected mobility, and assessing their impacts particularly under scenarios of autonomous or self-driving on-demand shared mobility. To demonstrate the feasibility of the approach, the paper provides initial results from a pilot study on a small road network in Melbourne, Australia. A base case scenario representing the current situation of using traditional privately owned vehicles, and two autonomous mobility on-demand (AMoD) scenarios were simulated on a real transport network. In the first scenario (AMoD1), it was assumed that the on-demand vehicles were immediately available to passengers (maximum waiting times is zero). This constraint was relaxed in the second scenario (AMoD2) by increasing the allowable passenger waiting times up to a maximum of 5 minutes. The results showed that using the AMoD system resulted in a significant reduction in both the number of vehicles required to meet the transport needs of the community (reduction of 43% in AMoD1, and 88% in AMoD2), and the required on-street parking space (reduction of 58% in AMoD1 and 83% in AMoD2). However, the simulation also showed that this was achieved at the expense of a less significant increase in the total VKT (increase of 29% in AMoD1 and 10% in AMoD2). The paper concludes by describing how the model is being extended, the remaining challenges that need to be overcome in this research, and outlines the next steps to achieve the desired outcomes.


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## 1. Introduction

The reform of urban mobility remains one of the biggest challenges facing policy makers around the world. Today, more than half the world's population lives in towns and cities and the percentage is growing. By 2050, 70 percent of the world is expected to live in cities and urban areas. According to the McKinsey Global Institute (MGI, 2011), just 100 cities currently account for 30 percent of the world's economy. New York City and London, together, represent 40 percent of the global market capitalisation. In 2025, 600 cities are projected to generate 58 percent of the global Gross Domestic Product (GDP) and accommodate 25 percent of the world's population. The MGI also expects that 136 new cities, driven by faster growth in GDP per capita, will make it into the top 600 by 2025, all from the developing world, 100 of them from China alone. The 21st century appears more likely to be dominated by these global cities, which will become the magnets of economy and engines of globalisation. The problem is further compounded by ageing infrastructures which in many cities are at a breaking point with governments' budgets for major infrastructure projects under increasing pressure. Furthermore, according to the United Nations Road Safety Collaboration (UNRSC 2016), it is estimated that 1.3 million people are killed on the world's roads each year. If left unchecked, this number could reach 1.9 million fatalities worldwide by 2020. The World Health Organisation (WHO 2015) has described road casualty figures as being of 'epidemic' proportions, with road-related trauma being the biggest single killer of those aged between 15 and 29. Over 90% of road crashes are associated with human error imposes a hefty amount of damages in terms of human and economic (International Transport Forum [ITF] 2014). A number of studies reported in the literature have also documented evidence showing that the environmental footprint of traditional transport systems, and in particular private vehicles with combustion engines, is not sustainable (ITF 2010). Globally, transport sector accounts for 27 percent of the world's total energy consumption 75 percent of which is sourced from non-renewable fossil fuels. Australia's per capita CO2 emissions are almost twice the OECD (Organization for Economic Co-operation and Development) average while transport contributes 14 percent of GHG emissions (Australian Council of Learned Academies [ACOLA] 2015). Moreover, road traffic continues to account for around 80 percent of transport CO2 emissions and is estimated to reach 9,000 Megaton per year by 2030 if the current mobility trends are not curbed (ITF 2010).

Pursuing conventional mobility trends with emphasising on building new infrastructure in order to respond to demand increase has over the years proven to be ineffective in meeting these challenges, and would result in a vicious cycle depleting resources while failing to achieve sustainable transport systems. New approaches are needed.

## 2. The opportunities

Decision makers and leaders who run these complex cities are increasingly recognising the role of smart technologies in improving the efficiency of existing infrastructure and sweating of assets through better utilisation of available infrastructure (Dia 2013). These systems can significantly improve operations, reliability, safety, and meet consumer demand for better services with relatively small levels of investment. Cities are essentially made up of a complex network of systems that are increasingly being instrumented and interconnected, providing an opportunity for better infrastructure management. An "Internet of Things" comprising sensors, monitors, video surveillance, and radio frequency identification (RFID) tags, all communicating with each other to enhance infrastructure capability and resilience, and capturing volumes of data. Through data mining, artificial intelligence and predictive analytics tools, smart infrastructure systems can help city managers to monitor the performance of vital infrastructure, identify key areas where city services are lagging, and inform decision makers on how to manage city growth and make our cities more liveable (Dia 2013).

## 3. New paradigm: technology-driven urban infrastructure

Smart cities of the future will include advanced network operations management and control systems that utilise field sensors to detect and respond quickly to equipment and infrastructure faults. Vital infrastructure downtimes will be cut using sensors that monitor the health of critical infrastructure, collect data on system functioning, alert operators inside an integrated urban control centre to the need for predictive maintenance, and identify potential