1. Introduction to the *Handbook of Public Transport Research*

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1.1 PUBLIC TRANSPORT – INTERESTING, INTELLECTUALLY CHALLENGING AND IMPORTANT

This *Handbook of Public Transport Research* aims to provide a comprehensive overview of the latest research in a growing field: the field of research on urban public transport. The quantity of public transport related research papers has doubled in the last nine years. Why? For two reasons.

First, researchers have been increasingly inspired by the topic. It is an applied and practical topic affecting the quality of life of billions of people. It is also a field with significant challenges, seeking new and original solutions. These challenges range from the difficult interface of engineering, operations and human perceptions in user satisfaction and performance management, to the tricky balance between prudent financial management, operations planning and the social access goals making subsidies essential. These challenges require a multi-disciplinary perspective to wicked problems in Engineering, Planning, Psychology and Design, which is why the field is intellectually as well as tactically challenging. The foundation of many of these challenges is the conflicting congestion and environmental relief, and the social equity objectives that justify public transport in cities.

Secondly, public transport in cities is growing globally and indeed is expected to grow significantly into the future as mega cities multiply and increasingly become the focus of human development. In 2007, for the first time in history, more than half of the world's population lived in cities (United Nations Population Fund 2007). Humanity's urban population is expected to double between 2000 and 2030. The twenty-first century is considered the 'Urban Millennium' where cities and how they function have a principal influence on the human race and its future (United Nations Population Fund 2007). Travel in most world cities has been dominated by the private car (Cosgrove et al. 2009), which is both a problem and an opportunity for public transport expansion:

- Traffic congestion is widely recognised as a major and growing global problem (Cervero 1991; Downs 1992; Arnott and Small 1994). In Australia congestion costs \$Aust 9.4 billion p.a. (2005) and is expected to rise to \$Aust 20.4 billion by 2020 (Bureau of Transport and Regional Economics 2007).
- If humanity is to live in cities, urban liveability and the quality of urban living is of critical importance. Yet there are important social impacts of car traffic on urban liveability (Vuchic 1999) including the separation of urban communities by busy roads and impacts on social disadvantage (Rosenbloom 2007).
- The climate crisis is often manifest in cities and in private car travel which was the only sector of the UK economy for which environmental emissions in 2007 were

higher than in 1990 (Woodcock et al. 2007). They are also increasing globally and remain a major focus of concern for greenhouse gas and climate change (Bureau of Infrastructure Transport and Regional Economics 2009).

- Obesity and an aging population are major concerns for the future of humanity. Strong links have been established between physical activity and health (British Medical Association 1997) (Dora and Phillips 2000). Public transport use involves more physical activity compared to car travel, suggesting growing health concerns as car use increases (Woodcock et al. 2007).
- Motorised transport is over 95 per cent dependent on oil and accounts for almost half of world use of oil (Woodcock et al. 2007). There is a growing consensus that oil reserves are falling and that the costs of transport will increase as a result (Dodson and Sipe 2008). These issues suggest significant risks associated with car-dependent transport futures.

1.2 PUBLIC TRANSPORT RESEARCH

All aspects of public transport warrant a research focus including ridership, user behaviour, planning, policy and operations. An implied and often hidden objective of this research is to improve how public transport systems are developed and operated using insights from research.

It is important that practitioners as well as academics understand what research is. Research concerns the development of *entirely new knowledge* to find new insights into problems in public transport. It does not concern the use of existing knowledge, which is what the consulting and planning industry adopts to solve the problems. By its very nature, research in public transport is thus new, innovative and original. It is also a very powerful tool because of this.

The field of public transport research is also necessarily broad and multi-disciplinary. Topics range from psychology to engineering, from governance to operations and from theory to practice. A flavour of contemporary research in public transport has been research that combines disciplines to provide new insights. This is never quite as easy as it sounds since each discipline has a language that is often indecipherable to others and practices that limit flexibility. Addressing these barriers is both necessary and a personal motivation. A significant power to solve problems in public transport comes from cross-disciplinary research. The public transport field is also useful for researchers because it is notably prolific in generating numerous complex, confounding and ‘wicked’ problems that need a cross-disciplinary solution.

The field of public transport research is also by nature practical or practice focused and thus less theoretical than most academic research. I have always seen this as a significant advantage since I consider it the purpose of academia: to help solve problems in the real world. However, not everyone in academia agrees and indeed there are significant barriers between practitioners and academia. There is much truth in the view that the ‘ivory towers’ of academia are remote from the reality of everyday concerns. For example, research papers in leading journals are difficult to read and access for most practitioners. Public transport research has a significant challenge in making it easier for practitioners to access and understand research. This is another motivation and rationale for this *Handbook*.

1.3 BOOK AIMS AND APPROACH

This book aims to provide a comprehensive overview of the latest research in the field. So my first major challenge in assembling the book was to find the latest, most interesting research from the best researchers. I had a significant advantage in being able to do this; in 2010 my research team (The Public Transport Research Group at Monash University) developed a free research tool to help the world public transport industry get better access to research and researchers in the field. It is called the World Transit Research Clearinghouse¹ and is a free database on the web which has gathered all published research papers in the world in the field. So I reviewed the database, found the best researchers and invited them to contribute. The good news is that they said yes.

A side benefit of this approach is that the book is necessarily international in flavour. Although research applications may cover public transport systems in their native countries, the research and its findings focus on the international implications for all public transport. The book has a total of 49 authors from nine countries, from 22 universities and five private sector agencies.

I had another important advantage which I also used for this book: I am fortunate to know and work with some of the most promising young researchers who are doing tremendous and important work. There is an obvious element of ‘blowing our own trumpet’ in some of this; authors from the Public Transport Research Group provide six of the 20 main content chapters of the book. However, this is justified by more than just my familiarity with their research; independent evidence supports the status of our outputs in the field.² I hope you, dear reader, will be as inspired as I am by their work.

One last point of focus for the book is that it is very public transport mode neutral; I don’t care if the wheels have rubber or steel or indeed if there are any wheels at all. What matters is quality, and we can learn a lot about that from all public transport modes, but most of all from our users and their experiences.

1.4 BOOK STRUCTURE AND CHAPTERS

The book includes 21 chapters, 20 chapters of content papers plus this Introduction. It is structured around five parts:

- *I. Research Foundations, Trends and Futures* – which includes ‘research on research’; findings from two separate meta-studies of research in the field of public transport to provide insight on what the field is, how it has been changing and where it might be going in future.
- *II. User Perspectives* – comprising four chapters on user focused research and the insights it provides on how public transport can better consider user needs in service design and management.
- *III. Policy Perspectives* – including four chapters covering the strategic issues of governance, road space management and funding.
- *IV. Planning and Operational Perspectives* – including seven chapters on issues as diverse as operational control, reliability and network resilience.

- *V. Service Development and Future Perspectives* – with three chapters exploring mobility futures, advances in customer information and ways to improve bus systems.

Chapters in the book are now outlined:

I. Research Foundations, Trends and Futures

Chapter 2: ‘World transit research: state of the art’ explores the field of public transport research using the World Transit Research Clearinghouse database as a source. Research trends and patterns are explored including geographical spread of publications, citation rates and leading authorship patterns.

Chapter 3: ‘Methodologies for empirical research on the link between the built environment and transit use’ presents a meta-study on the complex but important field of research linking the built environment in cities to public transport ridership. This chapter provides an overview of the theoretical frameworks, sampling and estimation methods and indicators relevant to designing empirical built environment and transit use research. Case studies are used to demonstrate the trade-offs that need to be considered when choosing between alternative approaches.

II. User Perspectives

Chapter 4: ‘Transit customer satisfaction research: is the customer always right?’ presents research results on new approaches to customer satisfaction measurement. It uses customer complaint data integrated with real-time service operations data as a new tool to understand customer perspectives.

Chapter 5: ‘Personal safety on public transport: research frontiers and new tools for an old problem’ presents new tools to address a major problem for public transport: crime and perceptions of crime. It describes results of the first research project ever to quantify factors affecting perceptions of safety (POS) at stations and the relative influences of station design quality, anti-social behaviour (ASB), crime rates and individual psychological and social-demographic factors.

Chapter 6: ‘The power of design to enrich the public transport experience’ comes from the emerging field of design research and illustrates how designers explore problems in the field of public transport and how this can enhance understanding of the customer experience. It includes a range of examples from the authors’ work in public transport.

Chapter 7: ‘The paradigm shift in revenue protection research and practice’ presents the findings of an innovative research project exploring the motivations of passengers who fare evade and how to mitigate the problem. This research provided new tools to help understand fare evaders and to improve management of the issue. The research had considerable impact, reducing evasion by over half and saving billions of dollars in cities that adopted the approaches identified.

III. Policy Perspectives

Chapter 8: ‘The governance of public transport: towards integrated design’ explores theories and research in the field of public transport governance from a wider set of

perspectives. It explores interactions from the various agencies and their functional regulatory perspectives including a review of levels of governance and the mechanisms of governance models. It includes recommendations on designing governance and its mechanisms into the future.

Chapter 9: 'The total social cost (TSC) of public transport modes' explores the concept of the Total Social Cost (a summation of operator, user and external costs) as a means of understanding public transport modes and their impact. Several international applications are used to explore this concept. Prospects for the use of this concept into the future are also discussed.

Chapter 10: 'New approaches and insights to managing on-road public transport priority' presents a new perspective on an old problem: successful implementation of on-road traffic priority for buses and trams. This approach moves on from 'techno rationalist' engineering perspectives of the problem to recognise and deal with the perceived intractable problem of politics and power which often constrains the development of priority in cities where car-based priorities dominate politics. The field of policy studies is described and pragmatic approaches to managing the problem of power and politics are presented.

Chapter 11: 'Paying for public transport' presents the results of research exploring the efficacy of alternative funding options for public transport with a focus on options explored in the United States. The chapter discusses use of these options in real-world circumstances, and assesses their strengths and limitations. The chapter concludes with reflections on the funding mechanisms and calls for additional research on their use.

IV. Planning and Operational Perspectives

Chapter 12: 'Public transport network resilience' presents the concepts of network resilience in public transport including the properties of service disruptions, methods of measuring resilience and disruption impacts. Approaches to mitigation of disruption impacts and methods of improving network resilience are reviewed.

Chapter 13: 'Service reliability: a planning and operations perspective' is a review of service reliability research in public transport. Definitions, impacts, indicators and improvement measures are presented and discussed. Indicators to understand the level of service reliability are presented and the chapter concludes by addressing how to improve service reliability through an appropriate design of public transport networks and schedules, in addition to control measures.

Chapter 14: 'Rail transit disruption management: a comprehensive review of strategies and approaches' provides a critical review of the state of knowledge in rail disruption management strategies, modelling, and analysis, with special emphasis placed on unplanned disruptions. The chapter summarises lessons learned from research and identifies gaps and future directions for research in the field.

Chapter 15: 'Demand management in urban railway systems: strategy, design, evaluation, monitoring and technology' synthesises demand management strategies and technologies in traffic and public transport, and develops a general public transport demand management (PTDM) framework including novel methodologies using fare card data for problem identification, design, evaluation and monitoring. Case studies illustrate successful applications of these approaches in practice.

Chapter 16: 'Transit signal priority: research and practice review and future needs'

provides a detailed review of transit signal priority systems, research literature and industry practices to derive insights on successes and challenges in real-world implementations. It also identifies possible future research directions including the significant potential of more advanced control systems.

Chapter 17: ‘ACES technologies and public transport operations and control’ presents an analysis of the impacts and opportunities for public transport systems of four technological trends related to operations and control: Autonomous, Connected, Electric and Shared (ACES) vehicles. Policy-setting for better implementation of operations control is discussed as are challenges in implementing transitions in the technologies of control.

Chapter 18: ‘Research in public transport vehicle scheduling’ reviews the latest research, approaches and computerised software packages to address transit vehicle scheduling problems (VSPs). The focus is on practical methods and tools for scheduling vehicles in transit agencies from around the world. Case study examples and applications are described and future directions for research in the field are discussed.

V. Service Development and Future Perspectives

Chapter 19: ‘Incorporating Mobility-on-Demand (MOD) and Mobility-as-a-Service (MaaS) automotive services into public transportation’ focuses primarily on Mobility-on-Demand services, particularly microtransit and transportation network companies (TNCs, also known as ridesourcing and ridesharing), and their integration with public transportation service in the USA. An analysis of partnership models is provided and a state of the art review of modelling of their impacts is presented. New research frontiers in the field are outlined.

Chapter 20: ‘Large increases in bus use in Sweden: lessons learned’ explores two case studies in Sweden where bus systems have been improved and examines the implications for practice in the field. Improvement measures, their design and implementation are described, including the impacts these had on ridership and customer satisfaction. Implications for research and practice are outlined.

Chapter 21: ‘Advances in transit customer information’ describes the history and benefits of transit information as practice has evolved from printed schedules to ubiquitous real-time information. It explores contemporary standardised data formats that have enabled a transit data revolution, especially the General Transit Feed Specification, as well as related web and mobile applications. Futures for transit information including Mobility-as-a-Service (MaaS) applications are also discussed.

1.5 WHEN A BOOK IS MORE THAN A BOOK

As is fitting with a book exploring research advances in planning practice including new approaches and technologies, this book also offers readers an alternative approach to better understand the research and researchers presented in this book. To supplement chapters in this book the Public Transport Research Group at Monash University has interviewed selected authors and will present these as selected episodes of our *Researching Transit* podcast series. *Researching Transit* can be found on all major podcast platforms or accessed via our website.³ Search for podcast interviews with authors of chapters in this *Handbook*.

NOTES

1. See www.worldtransitresearch.info.
2. In 2015, an independent world review of academic research in the field of public transport (Heilig and Voß 2015) found that public transport research at Monash University was the leading research group in Australia and among the top three in the world.
3. See www.ptgr.info and click on the podcast option on the homepage.

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