Urban ferry systems: Planning, development and use of contemporary water-based transit in cities

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December 2016

Thesis submitted to the Griffith University School of Environment for the award of Doctor of Philosophy

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Urban ferry systems: contemporary planning, development and use of water-based transit in cities

Key words

Ferries, water transit, public transport, ferry oriented development, economic benefits, transport planning, policy innovation.
Abstract

Increasing population growth in urban areas has led to significant problems, stretching the limits of existing urban transportation systems. While once playing a critical role in transport in the early development of cities, water transport has since declined sharply in relevance with increases in bridges, tunnels and the widespread proliferation of automobiles. But land based mass transit systems are often reaching capacity. These issues have led to a resurgence of interest in the use of urban ferry services as transport corridors along currently underutilised waterways. Cities such as Brisbane, New York, London, Gothenburg and Bangkok have operating urban ferry systems which play an important role in the transport functions of each city. In order to provide a better understanding of the operation of water transport services, their wider impact and the implications for their inclusion in future city planning, this thesis investigates key issues for planning this form of transport.

This thesis involves five pieces of discreet work under three phases of research which together seek to achieve this objective. An introduction in Chapter 1 provides an overview of how and why such water transport services have been introduced and the ways in which this innovation was developed, particularly in terms of the contemporary linear route configuration. It spells out the research gaps, the thesis research questions, and the overall approach and methods of the study. Five published and submitted papers then follow, inserted into the text as ‘chapters’, each of which is preceded by introductory remarks to help maintain continuity and to guide the reader through the narrative arc of the thesis.

The first phase of the research responded to transport planning questions around why such systems are being planned and implemented. Chapter 2 explores the introduction of the CityCat ferry system in Brisbane in the late 1990’s. It was found that a strong political champion and supporting coalition of bureaucrats and other key actors, aided by fortuitous circumstances and timing, allowed this unfamiliar mode to be implemented in Brisbane. The system was a key element in the concurrent citywide dialogue of re-imaging Brisbane as a ‘river city’, amongst other supporting policies. The system has since become an integral part of the transport network in Brisbane. Significantly, it has evolved from its initial transport and tourism functions, to play an important economic catalyst role in urban waterfront development plans as part of an ongoing waterfront urban renewal agenda in Brisbane.
Chapter 3 takes this case study and expands it to a global context and investigates a subset of compatriot systems worldwide, including examples from North America (New York), Europe (Copenhagen and Gothenburg) and Asia (Bangkok). The study found that while similar in operation, urban ferry systems were introduced for a number of reasons dependent on the individual context of the city. Ferry systems usually displayed a primary reason for implementation, but also provided key secondary supporting roles that in many cases were critical in the introduction of such systems. For instance, where transport service capacity alone did not warrant proceeding, economic development factors (as in Brisbane) and tourism and city branding functions (as in Copenhagen) were found to be important considerations underpinning the development of water transit. The research suggests that the assessment, planning and implementation process of developing urban ferry services need to be considered within a wider context of city planning in order for an accurate assessment of the applicability of such a system to be made.

With an understanding of how urban ferry systems came into operation and the function they serve, phase two of the thesis moved to respond to questions about how such systems are actually being used in an urban transport context. This was achieved through two studies looking in depth at the CityCat system in Brisbane using available smart card transaction data. Firstly, Chapter 4 provides the first published study of urban ferry travel patterns using smart card data. It investigates travel time and frequency, transfer between other public transport modes, and importantly, how people are using services in the context of a linear configuration as opposed to previously operating cross river only services. The results indicate that although it is a minor mode of transport in Brisbane (3% of all trips), the CityCat ferry system provides significant transfer between modes, with 15% of all ferry journeys incorporating other modes such as rail or bus. It was also demonstrated that passengers were actively using the linear nature of the system with 84% of all journeys incorporating a journey longer than two stops, up or down river. This finding shows empirically for the first time that efforts toward combining ferry terminals in an adaptation of Transit Oriented Development (TOD), as Ferry Oriented Development (FOD), have been successful in replicating the ‘pearls on a string’ development model of water transport.
Chapter 5 goes further in exploring this data to assess what premium value, if any, an urban ferry system has within a public transport network. It asks why people use water transit when in many cases a quicker bus alternative that serves the same origin-destination pairs is available. It hypothesises, based on existing theoretical studies, that water transport may offer users increased amenity value. The study design includes a comparison of selected origin-destination pairs and uses smart card transaction data to compare the journeys of bus and ferry passengers between these pairs. A logistic regression model was used to assess the variables that passengers considered when choosing directly between these modes. The results demonstrate the presence of excess travel in the journeys, where users were shown to choose ferry trips despite longer travel times (time coefficient = 2.779, OR= 16.103). Ferries were also chosen despite a lower frequency of departures (frequency coefficient = -0.143, OR=0.867), and were more popular in the AM peak period (coefficient= 2.25, OR= 9.487). This is the first known study to empirically establish and quantify the additional amenity benefits that urban ferry systems provide compared to other modes using revealed travel behaviour analysis. Moreover, Chapter 5 gives further support to the suggestion in Chapters 2 and 3 that urban ferry systems are inherently different to other urban transit modes and should be planned taking these additional, unique factors into consideration.

Finally, the third phase of the research sought to look toward the future role of urban ferry services in cities and ask how they can be planned in the future and what factors are important in their implementation for ongoing success. A particular focus was in terms of integration with other transit modes. To achieve this, Chapter 6 used a case study of the Chao Phraya Express Boat service in Bangkok, Thailand. Bangkok is currently undergoing a period of rapid transit modernisation, including investment in a large scale rail expansion program that threatens the role of boat services in Bangkok, which have traditionally not enjoyed the same level of support as rail services. This provided an ideal case for assessment of how urban ferry systems may find their place within existing and newly planned urban transport networks. The study finds that unlike other cities such as Brisbane and Copenhagen, which have identified the wider role water transit can play and which have leveraged this to achieve other objectives, Bangkok has not yet undergone this transformation. With a longer operating history of linear ferry routes and lack of development, the services are seen as antiquated and not fit for further investment. This is in contrast with the modernist view of rail and a focus on this mode to service the transport function of Bangkok in the future. However, like other
cities, Bangkok is going through a process of waterfront regeneration in conjunction with the rapidly developing economy of Thailand. As such, opportunities exist for water transport to be incorporated within this agenda as in other cities, where ferry upgrading initiatives are placed within the context of wider city development plans. If its services are planned well and collaboratively with other transport modes, Bangkok’s urban ferry system may develop to play a significant role in its transport future. However, unique political and organisational barriers continue to impede progress. The study helps to provide an insight into the facilitators and barriers of urban ferry development in general, and specifically, the factors in developing countries which are taken into consideration when seeking alternative sustainable transport options.

It is shown in this research that, while still a relatively minor mode, urban ferry systems can play an important role in helping to alleviate transport problems and in providing cities with another tool to expand their public transport offer. Water transit has been shown to provide additional benefits to cities besides transport. However, this research finds that in order for this to occur, these systems need to be considered within a wider context than just passenger transport alone. The supporting roles ferries provide should be considered in the planning phase when considering their suitability. This study finds that when assessed on transport capacity alone, such systems may not be a feasible option. However, when placed within a wider land use and city development context, such as economic development and tourism, urban ferry systems may provide a solution that not only benefits transit capacity but simultaneously provides other city-wide benefits. Such ancillary functions may prove to be the key justification for such services in cities.

Furthermore, this thesis suggests an expansion of the assessment of transport systems beyond travel time, taking into consideration such benefits as comfort and psychological enjoyment of travel, which ferry journeys provide. While not suitable for all circumstances, by including these factors urban ferry services can be more accurately evaluated for suitability in cities looking to expand their transport networks. This research therefore answers strategic planning issues which are relevant to cities that are considering an urban ferry system. It is useful to these cities in the short term, but also in the longer term to promote further research in the field of urban water transport.
List of publications and submitted manuscripts comprising this thesis

This thesis includes published papers that were co-authored with other researchers. It also includes papers that have been submitted and are currently under peer review. These papers were produced during PhD candidature only and comprise the thesis by publication. The bibliographic details (if published or accepted for publication)/status (if prepared or submitted for publication) for these papers including all authors are:

Published papers:


Papers in review:

Conference presentations and posters related to this thesis


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<th>Description</th>
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<tbody>
<tr>
<td>BCC</td>
<td>Brisbane City Council</td>
</tr>
<tr>
<td>BMA</td>
<td>Bangkok Metropolitan Administration</td>
</tr>
<tr>
<td>BRT</td>
<td>Bus Rapid Transit</td>
</tr>
<tr>
<td>CBA</td>
<td>Cost Benefit Analysis</td>
</tr>
<tr>
<td>CBD</td>
<td>Central Business District</td>
</tr>
<tr>
<td>FOD</td>
<td>Ferry Oriented Development</td>
</tr>
<tr>
<td>MCA</td>
<td>Multi Criteria Analysis</td>
</tr>
<tr>
<td>TOD</td>
<td>Transit Oriented Development</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for the Social Sciences</td>
</tr>
<tr>
<td>SEQ</td>
<td>South East Queensland</td>
</tr>
<tr>
<td>TDM</td>
<td>Travel Demand Management</td>
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Glossary of terminology

**Urban ferry system**
(A water-based public passenger transportation system that operates within an intra-city urban context. This includes cross river services and linear routes with multiple stops.)

**Ferry**
(In some cases ‘ferry’ can imply a simple cross river conveyance over a water body via a boat or other marine vessel. However, in the context of this thesis ferry (or ferries) is used interchangeably with water transit as per the definition above to describe all water-based urban passenger transport services within a city regardless of their configuration. Distinction is made with cross river only ferries where applicable.)

**Cross river ferry**
(Water-borne transport services that provide a direct connection between two stops on either side of a water body.)

**Linear (or parallel) ferry**
(A ferry system that operates parallel to a coast or river bank and which stops at designated stops along the way, connecting destinations.)

**Water taxi**
(Non-scheduled and demand-based ferry services that operate to transport passengers from one waterfront destination to another. Outside the scope of the research.)

**Terminal**
The definition of terminal adopted for this thesis incorporates any fixed platform where a boat or marine vessel stops for the boarding and alighting of passengers. This is equivalent to region specific terminology such as pier or pontoon. This does not indicate the terminus, or final stop of a transit line (see below).
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Terminus</td>
<td>The final stop on a transit route where services terminate.</td>
</tr>
<tr>
<td>Urban</td>
<td>The scale of a city where the boundary lies within close proximity to business and activity districts and is usually close to the city centre. This area does not encroach into peri-urban areas or rural and regional areas.</td>
</tr>
<tr>
<td>Peri-urban</td>
<td>The area on the fringe of the urban boundary, but not extending into rural or regional areas.</td>
</tr>
<tr>
<td>Rural</td>
<td>Areas outside the urban and peri-urban regional boundary. Usually characterised by greenfield land used for agriculture and other uses.</td>
</tr>
<tr>
<td>Regional</td>
<td>A large area encompassing the whole of an urban, peri-urban and rural area.</td>
</tr>
<tr>
<td>Intra-city</td>
<td>Within a city boundary.</td>
</tr>
<tr>
<td>Inter-city</td>
<td>Between two or more cities.</td>
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</table>
Statement of original authorship

I declare that this thesis has been composed by myself and that the work has not be submitted for any other degree or professional qualification. I confirm that the work submitted is my own, except where work which has formed part of jointly-authored publications has been included. My contribution and those of the other authors to this work have been explicitly indicated before each chapter. I confirm that appropriate credit has been given within this thesis where reference has been made to the work of others.

Michael Tanko
5 December 2016
Acknowledgements

Thanks must firstly go to my supervisor Associate Professor Matthew Burke who was not only a continual source of much knowledge and professional guidance, but also personal support when issues of completing a PhD inevitably arose. Without encouragement to continue on, and faith in my work I may not have completed this journey, and so I am eternally grateful. I am also thankful to my other supervisors, Dr. Barbara Yen and Professor Pan Haixiao for their support and encouragement. The collaboration with Dr Yen was particularly fulfilling in my professional development and so I thank her for her time and important contributions to the paper in Chapter 5. I must also thank the incredibly helpful support staff at Griffith University including Ann Krupa and Michelle Lovelle for their continual help and support. Thank you also to Emeritus Professor Patrick Troy AO, whose scholarship I received while an undergraduate was instrumental in helping me decide to pursue a PhD in urban studies.

I am also very grateful to the assistance I received whilst in Thailand in 2016 conducting research as part of Chapter 6. Firstly, thank you to Professor Agachai Sumalee for his support of my Endeavour Fellowship and accommodating my research needs. Thank you also to Associate Professor Antika Sawadsri and those at King Mongkut’s Institute of Technology Latkrabang for their assistance. I am also indebted to the Faculty of Architecture and Planning at Thammasat University, in particular Associate Professor Pawinee Iamtrakul, Yanyong Boonlong, Chompoonut Kongphunphin and Chatudom Tonmanee for their assistance in providing documents, contacts and conducting interviews in Thai. Without their help this thesis would not have been possible.

Many thanks to my parents who have always showed complete support and faith in the pathways I have taken in life, despite perhaps not always agreeing with them. Thank you also to my grandmother who always supported and believed in me even through difficult times. I am sure she would be proud that I finally have a job and so I must dedicate this thesis to her.

Finally, I am grateful to the support of the Australian Government through the Australian Postgraduate Award and also the Endeavour Fellowship scheme which allowed the critical research component in Bangkok to be undertaken.
1 Introduction

1.1 Introductory comments

This chapter provides an overview of the research agenda of this thesis by publication. Firstly, the object of inquiry is introduced, followed by the rationale for conducting the research. A review of transport theory relevant to the current research is then discussed. The current state of knowledge of urban ferry systems is then presented, followed by a summary of the research questions and aims. Finally, an outline of the dissertation structure is provided.

1.2 Object of inquiry

Urban traffic congestion, space constraints and pollution are increasingly affecting cities, and these are only predicted to get worse as more people move to urban areas (Bonnel, 1995; Wang et al., 2013). Transportation is one of the key contributors to these issues and, as such, better transport methods and solutions will need to be developed to counteract these negative effects in order to provide for more sustainable cities in the future. This research investigates one such transport solution for cities: urban ferry systems. Water transit is increasingly being used in cities to add a complimentary transit mode to a city’s existing transport network. Additionally, while traditionally ferry services offered mostly a cross river only service, new configurations have evolved to operate akin to a modern transit line, linking multiple stops along a river or coast in a linear route, for example the Thames Clippers ferry services in London (Figure 1).
1.3 Rationale for the research

In recognising transport capacity issues and congestion, policies have sought to emphasise new exclusive rights of way for transit such as metro rail services and Bus Rapid Transit (BRT) systems, which allow unobstructed rights of way and better traffic flow (Hoffman, 2008). However, financial constraints, long lead construction times and the politically unpopular nature of re-allocating existing land space to transit is an ongoing issue. Some scholars have suggested using existing waterways as alternative transit corridors that may offer a solution to land based transit congestion and offer a new resource for exclusive right of way transport in cities (Thompson et al., 2006; Weisbrod & Lawson, 2003). As will be shown, cities such as New York and Gothenburg have also used linear ferry systems to stimulate urban development and provide other city wide benefits, with other systems slowly expanding in number as well.
However, little is currently available in the literature describing modern urban ferry systems, about the processes behind systems being introduced, how they operate and compare internationally and how they are being used by passengers. The original contributions provided by this program of research are:

1. Identifying and describing the currently operating systems worldwide in order to understand the reasons for implementation and to understand their individual role in each context, and within the context of the wider city transport and urban planning processes that impact on the urban geography of the city.

2. Providing the first published insight into how urban ferry systems are used within a public transport network by an analysis of smart card transaction data.

3. Empirically demonstrating for the first time the premium value that urban ferry systems have within a cities’ transport network via revealed preference choice modelling methodology.

4. Exploring the facilitators and barriers to future water transit use and providing guidance for the further planning and implementation for existing and new urban ferry systems, particularly in the context of developing countries.

1.4 Urban development context

By the year 2009, increasing trends towards urbanisation had led the majority of the world’s population to live in urban areas. By 2030, 60% of the world’s population will live in cities (World Health Organisation, 2016). On one hand this trend can be seen to offer significant potential for not only job generation and increased incomes, but also for the more efficient delivery of education, health care and other services due to the benefits of scale and proximity (United Nations, 2007). However, on the other hand this urban configuration has created a wealth of additional problems. As a result, as more rural residents move into cities, many of these urban regions are now facing increasing demand for facilities and services to accommodate these new citizens (Department of Planning and Infrastructure, 2009).
Much debate has arisen about the question of how to accommodate this in the future and provide housing, health services, and utilities such as electricity and transport facilities. In particular, problems regarding transportation, including private car use have also recently become pertinent. These issues include peak oil (Dodson and Sipe, 2008), health impacts of car use including pollution (Maibach et al., 2009) and trauma (Kong et al., 2006), and the cumulative long term effects of climate change (Chapman, 2007). Such effects have led to calls for a reduction in private car use and the expansion of public transport in order to promote more sustainable cites in the future, including the use of water-based transit.

1.5 Waterfront history and development

Exacerbating the problem of land constraints, many cities have been founded on riverbanks or in coastal regions. Settlements were often established on river banks in order to take advantage of the readily available supply of water needed for agriculture and other essential services (Cudahy, 1990; Sintusingha, 2010). However, continued growth along these areas in coastal and riparian environments posed increasing constraints, such as limiting growth to along river banks and the severing of links between settlements on either side. Ferry services provided the first solution to connecting these settlements, and these services played an important role in the developments of coastal and river-based cities such as New York, London, Sydney and Bangkok. In coastal New York, for example, ferries served as the main transport thoroughfare until the mid-nineteenth century (Thompson et al., 2006).

However, as land-based transport became more abundant via the development of railways, trolley lines, tunnels and the increase in automobile use, urban development was no longer limited by physical distance and the need to be close to water resources (Cervero et al., 2004; Shiftan & Golani, 2005). As a result, a retreat from the waterfront occurred as ferries declined in importance as a transport mode. Rivers came to be seen as a hindrance that needed to be overcome, with modern solutions often calling for extensive bridge building efforts (Baldacchino, 2007; Cottrell, 2011). Subsequent projects have suggested the damming of rivers, and several land reclamation proposals, included suggestions to pave over New York’s waterways in 1934 and again in 2009 (Urstadt, 2009). In Hong Kong, land reclamation become a development policy focused not only on creating new land but forming artificial land bridges between once unconnected land masses (Ng & Cook 1997; Grydehøj 2015).
Bangkok, the modus operandi since the automobile age has been to pave over its once extensive canal network to accommodate new roads (Thammasat University, 2015).

However, the limits to this growth strategy and its environmental impacts are increasingly being questioned (Ng & Cook 1997). The importance of waterfront environments is starting to gain value again, environmentally, socially and economically. Plans to re-orient cities toward their waterways are currently under way in many cities, including New York and Bangkok (New York City Economic Development Corporation, 2013; Thammasat University, 2015). There are a number of reasons for this resurgence of interest in inner city waterfront areas. Firstly, the global decline in manufacturing and shipping in inner city port areas has been replaced by large scale operations and ‘containerisation’ down river (Baird, 1996; Levinson, 2006). Many of the remaining unused areas have coincided with an increase in preference for inner city living, particularly in waterfront districts. Examples include the Teneriffe and Hamilton districts in Brisbane, the development of South Bank in London, and most recently, the East River Waterfront Redevelopment Plan in New York.

Secondly, some cities have sought to promote the image of a ‘river city’ through city branding and tourism initiatives. As will be shown, water transport has been one of a suite of polices coordinated with new residential and commercial land uses centred around rivers which has facilitated the development of these areas (Weisbrod & Lawson, 2003). Finally, advances in marine technology have allowed urban ferry systems to become feasible public transport modes. Modern high speed and high capacity vessels are increasingly competitive with other public transport modes. In cities with sensitive environmental conditions, the technological advance in the production of low wash vessels has also been critical in allowing water transport development in urban areas. Along with the promotion of environmentally benign modes of transport such as walking and cycling, public transport expansion, including water transport services, is critical in making a shift to more sustainable transport in cites.

1.6 Traditional transport planning

Before introducing the characteristics of modern urban ferry systems, it is necessary to establish relevant transport theory and concepts that relate to the political processes of introducing transport, how decisions are made, and the ongoing operation and development
of such systems. Transport and land use planning continues to be shaped by institutional, political and professional imperatives. It is largely focused on determining how resources are allocated to transport infrastructure to secure the best possible solution within the limited availability of resources (Black, 1981). Traditionally such planning has been done through a ‘systems approach’, which has focused on a linear process of developing quantitative methods to understand the problem and estimate future demands and scenarios (McLoughlin, 1969). The solution often involves designing standards and interventions that meet the forecast transport needs (Figure 2). An example is the ‘predict and provide’ model of accommodating automobile use, where a combination of techno-rational analysis and infrastructure expertise results in the standard development pattern of providing for roads and highways to accommodate the predicted flow of traffic (Adams, 1981; Banister & Button, 1992; Owens, 1995). Martens (2016) observes that:

> A lack of capacity, whether measured in terms of Levels of Service (LOS), congested roadway miles or the number of vehicle hours lost is seen as the prime transportation problem to be solved by planning. (Martens, 2016, p.25).

The prevalence of engineering expertise in planning departments has also traditionally favoured the reproduction of ‘hard’ infrastructure solutions, largely shaping the subsequent course of transport planning (Mees, 2000). However, the shortcomings of such models became pronounced through the 1960s and 70s, as this top down development style often had little consideration for social or environmental impacts. With the increase in social movements and community engagement in politics came the demand for more input from the public in the planning process (Healey, 1998; Campbell, 2016).

Jane Jacobs’s *The Death and Life of Great American Cities* (1961) was critical in arguing against the status quo, and showed the influence of social movements in shaping the dialogue around transport policies and development. Transport projects that were until that time considered as inevitable progress and unequivocally beneficial, were now questioned about the value they offered in comparison to the lively, interesting, unstructured urban environments that they were to replace (Jacobs, 1961, pp.352–354).
In terms of environmental impacts, the negative effects of transport projects including pollution, road trauma and increasingly climate change concerns have led to questions about increased transport provisions, with instead an increasing focus on accessibility and equality in transport (Geurs & van Wee, 2004; Martens, 2012, p.19). Hence, it was no longer possible for transport planners to justify the construction of highways and other road projects that impacted negatively on local communities.

1.7 Transport planning paradigm shift

As a result the transport planning process has evolved to incorporate a more communicative planning process characterised by an iterative, deliberative approach to conceptualising issues and forming solutions (see Forester, 2001). This established a precedent for consultative processes that are now embedded in most transport planning projects as part of a formalised
public consultation phase. Such developments were evident during the 1980’s and 90s with a shift towards ‘balanced planning’. In response to ongoing protests against freeways, policy responses also now planned for public transport programs. The successful ‘New Ways Not Freeways’ campaign in Queensland, Australia, was an example of such a shift in policy considerations (Krosch, 2009; Krosch, 2010). The changes from the 1965 Wilbur Smith highways plan for Brisbane to the 1997 Integrated Regional Transport Plan (IRTP), which focused on balancing an integrated transport network for South East Queensland, also showed this characteristic shift in transport planning (Wilbur Smith and Associates, 1965; Queensland Transport, 1997). However there was criticism of this shift suggesting that it wasn’t really balanced at all, given the expenditures on freeways and roads and subsidies for car travel in nations such as Australia (Mees, 2009).

But there were other shifts in transport planning that paralleled this. For instance, from the 1960s onwards developers were increasingly required to produce ‘traffic impact assessments’ for new developments in order to demonstrate the implications of their proposals and help authorities make informed decisions. However, these have increasingly been expanded into ‘transport impact assessments’ that incorporate walking, cycling and public transport issues (Hutton, 2013). Evidently the discourse of transport planning and its objectives was changing, with less emphasis on congestion relief only, and more interest in such issues as accessibility and sustainability.

So what drives contemporary transport projects and for what reasons are they implemented? In many ways the same economic determinants of providing the public good of transport for society remains. More people are moving to cities and the need to provide efficient movement is increasing. However, the definition of the ‘transport good’ has changed. Along with the previously mentioned social and environmental factors, increasing awareness of the limits to current methods of solving transport problems in more recent times has led to a paradigm shift in transport planning. Most notably transport planning has shifted from the conventional approach of transport planning and engineering towards sustainable mobility (Banister, 2008). The key conceptual difference in these approaches is highlighted in Table 1. This shift sees a significant change in the goals of transport planning to achieve the objectives of sustainable mobility (Poor & Lindquist, 2009).
Table 1: Contrasting approaches to transport planning (Banister 2008, p.75)

While previously focused on providing for unlimited personal mobility, there has been a shift to planning for accessibility, to offer access to jobs, goods and services in order to provide a more equitable distribution of the ‘transport good’ (Martens, 2012, pp.1038–1042). A key factor is the change in focus from the physical dimension of building infrastructure to a focus on the social dimensions. There is a change toward facilitating accessibility by changing travel patterns via transport and the increasing use of Travel Demand Management (TDM) strategies.
Perhaps most reflective of this shift is the recognition of problems associated with private vehicle use, and from providing personal mobility by road demand management strategies and new forms of urban design to promote sustainable transport (Dur et al., 2011). For example, there is now the concept of New Urbanism and Smart Growth, and questions about the need to travel in the first place by considering replacing travel with telecommuting. This impacts on how transport is conceived and considered in order to provide this adapted transport good in the most efficient way. In terms of accessibility and mobility, urban ferry services might offer more access than movement opportunities in this context, except in cities like Bangkok where, despite slower travel speeds of water transport, land based congestion is extreme.

1.8 Contemporary transport planning and analysis

However, despite this progress many of the existing frameworks for decision making in transport planning remain the same, such as the most commonly used Cost Benefit Analysis (CBA), which has emerged as the dominant tool for assessing transport projects (Bristow & Nellthorp, 2000). CBA is a decision making framework that weighs the values of a project in terms of the value it provides against the cost of implementing, operating and maintaining the project in order to choose the best option (Hanley & Spash, 1993; Mishan & Euston, 2007). It assumes that each transport intervention has its own strengths and weaknesses and associated costs, and attempts to quantify these in order to make a rational decision. In terms of transport, the main factors on either side of the equation are the benefits of time savings and costs of construction (Naess, 2006, pp.33–36).

Conventional economics tells us that people will act in order to reduce their travel times to maximise their personal utility, and thus the main goal of transport projects should be to reduce travel times (Hensher & Button, 2007). Transport projects are therefore primarily assessed on how effectively they will reduce travel times. To achieve this, the value of time needs to be defined, and this is often achieved by estimating the costs of time wasted in traffic congestion. This can then be quantified to a monetary value in terms of lost productivity. Such quantification has been influential in the justification of transport megaprojects, some having dubious merit in their own right (Dodson, 2009). Travel time savings have therefore been influential and have become a major pillar of the CBA process in
transport planning. On the other side of the equation are the financial costs of a project. CBA then weighs these options to find a ratio that quantifies a per dollar time saving value of proposed projects. As time savings is a key factor, often this travel time savings value largely dictates the favoured option (Hanley & Spash, 1993).

However, Naess (2006) suggests that there is a set of key problems and biases involved in the process. He firstly notes that the model is not an exact science and is only as good as the input data. If not all costs and benefits are included, or the values do not reflect real world situations, then the result will be poor. In particular, he highlights the key focus on time savings. Firstly, this is problematic as there is little guidance about standard values, leading to largely subjective and often arbitrarily valuations of time (Naess et al., 2015). For example, in 2005, the valuation of time benefits savings for journeys to work was shown to differ by a factor of 10 between two neighbouring European counties, Austria and Hungary. Costs are also prone to errors, with the discount rate levels ranging from 6% annually in the UK, 7% in the US and Australia, and up to 10% in Canada, contributing to serious reliability problems in the decision making process (Naess, 2006, pp.2–3). An assumption that users will always act rationally is also a problem, as users may not possess the assumed perfect information available to them in their decision making process. Furthermore, it has been observed that often passengers will have different personal travel preferences that are not considered in such a model (Liu et al., 2010).

Problems of unreliable inputs may also occur when one mode is ideologically favoured over another. In such cases figures may be exaggerated and skew the results. This can occur when an overly optimistic forecast of car usage for proposed new toll roads or tunnels favours construction, but this forecast never reflects actual demand and is subject to an ‘optimism bias’ (see Flyvbjerg et al., 2004; Flyvbjerg et al., 2009). In other cases, due to induced traffic demand, excess usage and capacity is reached which has not been forecast. This is usually ignored in these models despite the empirical evidence that supports this phenomenon (MOTOS, 2007, p.100; Naess et al., 2012; Naess et al., 2014). In this case the model may underreport demand and overestimate the usable life of the infrastructure, again leading to poor decisions being made. There are also cases when a ‘do nothing’ scenario exaggerates travel time costs to overstate the current problem, prompting an infrastructure response (Naess et al., 2015; Nicolaisen & Naess, 2015).
In terms of public transport, this can also be seen in the favouring of one mode over another. Richmond (2005) uses the case of the proposed light rail system in Los Angeles, despite more effective and cheaper transport solutions being available. Initial ridership predictions of 100,000 people were revised to 10,000, so that when the system opened to 14,000 the proponents of the system were able to claim above-predicted ridership. The mythical conception of light rail as a ‘transport of delight’ is a form of techno-fetishism where it is believed that one technology may be a solve-all solution to a city’s problems, including social and economic as well as transport issues. In such cases technical analysis is not used to inform the decision so much as to legitimise decisions that had already been made. Furthermore, Martens (2016) also identifies the problem of basing future forecast on current experiences:

*By ignoring the fact that current travel patterns are a reflection of the way in which transport resources have been distributed in the past, transport models thus create an inherent feedback loop.* (Martens, 2016, p.29).

In effect he argues that transport modelling based on existing demand and existing inequalities, and forecasting based on this data only perpetuates the cycle of inequality and prevents fundamental progress toward more equitable transport systems.

Apart from incorrect values, omission of contributing factors, either costs or benefits, can also affect the reliability of the analysis. CBA was first used in assessments of car traffic projects, but there are now many options for transport, each with its own specific characteristics. However, fundamentally many of these factors have been fixed and this may not reflect updated technologies and the changing realities of how passengers travel. Martens (2006) notes that CBA currently only takes into account a limited number of factors (Martens, 2016 p.24). For instance, time is usually only considered as a cost in current modelling, but as will be shown in this research, under some circumstances time can also be considered to be a benefit, offering positive utility to travellers. For example, with the increase in information communication technologies (ICT) and the ability to work and socialise while travelling, travel could perhaps be considered to be saving time for some (Andreev et al., 2007). Such new research about the benefits and costs are unlikely to be captured in the current CBA framework. Martens (2012) also suggests a need to
fundamentally question these underlying assumptions and valuations that are the basis of current CBA in order to plan for fairer transport planning (Martens, 2012). Finally, CBA does not incorporate a measure of equity, which as will be discussed, is increasingly being called upon to be incorporated in the decision making processes in transportation planning (Currie et al. 2010; Epting 2016; Griffin & Sener 2016; Martens 2016; Pereira et al. 2016).

Evidently there are many shortcomings in the decision making frameworks where such influences and omissions are possible. As mentioned, while transport planning has adapted to social and environmental changes, many of the existing frameworks for decision making have remained static in their goal of reducing travel times and aiding in unlimited personal mobility. There are some key suggestions for why this occurs. In the case of incorrect inputs, this bias may result from ideological reasons where one mode has greater social acceptance vis-à-vis an alternative. For example, rail transport is often seen as preferable to travel by bus simply due to image. For political reasons, such impressions may be picked up by politicians as a platform. Such championing can lead to good outcomes, but as often, can lead to poor decisions being made by politicians and bureaucrats (see Hall, 1980).

Another source of bias may stem from embedded institutions and lobbyists (car or rail, etc.) who wish to maintain the status quo to protect their own interests. These established modes are largely a known quantity and, as will be discussed shortly, there is a strong tendency for these modes to be replicated, in effect increasing the barrier for new transport technologies or operating models entering a transport network. How urban ferry systems are conceived by planners, whether positively for modern catamaran systems such as in Brisbane, or negatively for older indigenous water transport systems like the Chao Phraya Express in Bangkok, is not well understood, and may have considerable implications for planning outcomes. As will be discussed, such differing attitudes toward transport modes can significantly affect the inputs of decision making models, swaying the decision in one mode’s favour. How this may affect water transport development or modernisation, especially in cities like Bangkok where competing public transport modes have strong embedded political support, is also not understood. We will look at such issues in more depth later, but at this point we turn to look at the main alternative to CBA that is in use, which seeks to allow for some of the other variables one may wish to include when planning a transport system.
1.9 Multi Criteria Analysis

Multi Criteria Analysis (MCA) is another decision making method that has been used to consider transport options, and it has been increasing in popularity due to its suitability for transport planning projects (Cascajo, 2005). MCA is able to incorporate the broader objectives of sustainable transport, including economic, social and environmental factors. Unlike CBA which relies on the monetisation of values, MCA is able to incorporate both quantitative and qualitative values, not necessarily in monetary terms. Table 2 shows a range of typical criteria used in a transport project under the objective of sustainable development, in its three dimensions, economic, social and environmental sustainability in order to compare options. In this case, quantitative values are supplemented by qualitative data in the form of collected surveys, with the responses then coded into a numeric factor.

<table>
<thead>
<tr>
<th>Sub-objectives</th>
<th>Criteria</th>
<th>Indicators</th>
<th>Quantitative/Qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Benefits</td>
<td>Reduction of travel time</td>
<td>Total travel time saved by the project in both, public and private transport, between the scenarios</td>
<td>Quantitative</td>
</tr>
<tr>
<td></td>
<td>Economic efficiency</td>
<td>Difference between ‘Fare revenues’ and ‘Operation costs’</td>
<td>Quantitative</td>
</tr>
<tr>
<td></td>
<td>Employment generation</td>
<td>Additional Regional Employment</td>
<td>Quantitative</td>
</tr>
<tr>
<td></td>
<td>Economic growth</td>
<td>Economic Development Effect</td>
<td>Qualitative</td>
</tr>
<tr>
<td>Social Benefits</td>
<td>Social Equity</td>
<td>Quantified questionnaire responses</td>
<td>Qualitative</td>
</tr>
<tr>
<td></td>
<td>Increase in the use of PT</td>
<td>Increase in public transport trips per day</td>
<td>Quantitative</td>
</tr>
<tr>
<td></td>
<td>Urban regeneration</td>
<td>Urban regeneration in the vicinity of PT.</td>
<td>Qualitative</td>
</tr>
<tr>
<td>Environmental Improvements</td>
<td>Air Pollution</td>
<td>Reduction of pollutant emissions (Tons/year of CO, SO₂, NOₓ, lead, PM)</td>
<td>Quantitative</td>
</tr>
<tr>
<td></td>
<td>Noise</td>
<td>Percentage of persons that are less affected by noise.</td>
<td>Quantitative</td>
</tr>
<tr>
<td></td>
<td>Greenhouse effect</td>
<td>Reduction of emission of CO₂ (tons/year)</td>
<td>Quantitative</td>
</tr>
<tr>
<td></td>
<td>Safety improvements</td>
<td>Reduction of accident costs per year (Euro/car-km.)</td>
<td>Quantitative</td>
</tr>
</tbody>
</table>

Table 2: Example MCA used for assessment of rail systems (Cascajo, 2005)
These indicators are then normalised across values into a scale from 0 to 1. Weights are then added to the indicators reflecting relative importance and a final assessment is conducted. MCA therefore has a greater potential for more diverse input, and from a wider variety of stakeholders, where a stakeholder differentiated MCA process is used. In this case, stakeholders are involved in the conceptualisation of options and in the decision making process itself and a greater range of options are potentially included in the decision making process. MCA is commonly used in transport planning practice, such as in the selection of the light rail mode in the planning studies which were prepared the Gold Coast Light Rail in Australia. These studies included non-monetary values such as pedestrian benefits in addition to monetised issues such as vehicle purchase costs (Parsons Brinckerhoff, 2003). The choice of what additional measures should be incorporated within both CBA and MCA has become a major concern for planners. We turn now to look at transport-specific measures that may have particular importance when we consider urban ferry systems.

1.10 Incorporation of additional values

Transport investments are increasingly being seen in a wider context than passenger transport alone. As a result, the decision making process may benefit from better inputs that reflect the more interdisciplinary nature of transport and land use planning and its effects on cities, such as the incorporation of additional and alternative factors that are currently not captured in existing processes. In the context of the current research, three main factors are increasingly relevant in transport planning: economic development opportunities (Banister & Berechman, 2001; Graham, 2006; Vickerman, 2007), travel time benefits (Singleton, 2001; Ory & Mokhtarian, 2005) and achieving equity imperatives (Martens, 2012; Griffin & Sener, 2016; Martens, 2016).

Transport projects are increasingly being justified in terms of their economic stimulation properties around stations and along transport corridors, along with other city wide benefits. Cities are increasingly pursuing Transit Oriented Development (TOD), which seeks to organise development around existing and new transit stops in order to further encourage public transport use, while discouraging car use (Cervero et al., 2002). TOD is also actively being planned as a method by which transport can dictate and lead more sustainable urban growth (Altoon & Auld, 2011). There have been numerous studies assessing value uplift
around Transit Oriented Developments (TOD) at rail stations (Cervero et al., 2002; Cervero et al., 2004; Dunphy et al., 2005) or Bus Rapid Transit (BRT) stations (Deng & Nelson, 2013; Zhang & Liu, 2015). However, its use in water transport applications is not as common. An adaption of TOD, Ferry Oriented Development (FOD) has recently gained momentum with ferry systems in Brisbane, New York and Gothenburg where there is a focus on integrating land use planning with existing and new ferry terminals.

Two key studies have so far explored the property value uplift effects of such systems. In a study around ferry terminals in Brisbane, Tsai et al. (2015) found that value uplift of 4% has occurred around terminals (Tsai et al., 2015). Similarly, the New York City Economic Development Corporation found that after a three year trial of the East River Ferry there was an 8% value uplift around ferry terminals. This result was a factor in the expansion of the initial trial to a new city wide urban ferry system connecting all five boroughs in New York City (New York City Economic Development Corporation, 2013). One issue currently, however, is a concern that developers are perhaps less willing to invest heavily in urban renewal projects near a ferry terminal which is not guaranteed to be a permanent structure (Thompson et al., 2006, p.33). As FOD is in its early stages this is a valid observation, however this impression may change with more successful implementations and evidence of value where permanence of service is demonstrated. The underdevelopment and the image of water transport compared to other public transport modes may also hinder the potential to spur economic development around such terminals, as has been observed in Bangkok (Hossain & Iamtrakul, 2007). So far, however, these studies have focused on individual cases and have not postulated how FOD differs from TOD in planning and development. As previously noted, other economic benefits of water transport have been suggested where they have been framed within a wider context of promoting river reorientation plans. We do not yet know much about how water transport is different in this way, but as this thesis will suggest, there are additional economic benefits that may be considered in the case of contemporary urban ferry systems.

The second factor worth considering is the identification of travel time benefits that are increasingly being reported in the literature (Redmond & Mokhtarian, 2001; Ory & Mokhtarian, 2005; Mokhtarian & Salomon, 2001; Wardman, 2004; Jain & Lyons, 2008; Lyons et al., 2007). As a result, there is now a questioning of the conventional wisdom that
travel time is a cost that needs to be minimised. It has been observed that in many cases, despite faster and easier travel, travel time in commuting has remained constant at an average of an hour (Metz, 2008). Furthermore, the identification of excess travel in commuting has shown that passengers may not always choose the shortest or more direct journey (Ma & Banister, 2007; Murphy, 2009; Fraszczyk, 2014). As will be shown in this thesis, the concept of equipped time (Jain & Lyons, 2008, p.116; Barr et al., 2010, p.71) is now allowing commuting time to be seen as being less of a barrier and more as a source of productive time.

There are a number of factors that aid in this which this thesis will explore. For instance, such considerations of travel amenity values may necessitate an adaptation of conventional CBA to incorporate these benefits instead of considering time as necessarily a cost alone.

Finally, equity is also becoming increasingly important as a factor in transport planning, with the shift from personal freedom of travel and mobility to the collective goal of universal accessibility. For example, recent studies have shown how accessibility can be unevenly distributed across society:

> A wealthy, time rich person who is able to access all transport systems may well experience the highest possible level of accessibility. But any person that experiences some resource limitation, in terms of e.g. money, time, physical abilities or cognitive skills, will experience a lower level of accessibility. (Martens 2016, p.12).

Addressing such concerns is becoming more important in transport planning. As will be discussed in the case of Bangkok in Chapter 6, equity is also an important consideration in the planned expansion of the public transport network where the preferred option is rail expansion. This option may be out of the reach of the majority of Bangkok commuters who predominantly use either buses or the urban ferry system which remains a critical lifeline for the majority of locals who use these services daily.

These examples of additional factors indicate how transport policies may have a wider impact and therefore need to be planned as such. However, the ways in which this can be incorporated in transport decision making processes still present a challenge. Economic considerations, such as in the business case prepared for the East River Ferry in New York, show that economic considerations can and have been explicitly incorporated in the decision
making process (New York City Development Corporation, 2013). However, more intangible values of travel time benefits and equity may prove more difficult to incorporate in analyses which overwhelming still favour quantifiable inputs and outputs (Martens, 2016).

On the other hand, one potential risk of incorporating additional factors such as economic or amenity benefits is that these values may override the core function of providing transport services. This may lead instead to a primary focus on monetary gains from transport projects. As will be discussed in Chapter 6, there are equity issues surrounding Bangkok’s rail station and land development agenda, as well as concerns over the continued development of ad hoc transport projects with dubious merit. Such overemphasis on economic benefits may shift focus from the primary objective of people moving and lead to poor transport outcomes.

Nevertheless, as will be shown in this thesis, the incorporation of additional metrics to assess public transport investment is important in formulating transport policy when used appropriately as justification, but not superseding the core goal of providing transport options. Furthermore, existing variables included in both CBA or MCA may also require reconceptualisation when considering water transport, in particular the value of travel time.

1.11 Excess travel and travel time utility

As noted previously, traditional utilitarian economic theory suggests that the individual will act to maximise their own utility (Zafirovski, 1999). The assumption that travel time is a cost implies that the goal of transport planning should be to minimise travel times, with time considered as a ‘much valued irretrievable resource’ (Cervero et al., 2001, p.15874). However, there has been a perceptible change in how people travel and how they use time. A key concept in this research is travel time utility, where travellers derive some benefit from the process of travel itself, apart from getting from A to B. The single objective of travel time minimisation is therefore now being replaced by new interpretations of why people travel and how they use time (Jain & Lyons, 2008). For instance, Mokhtarian (2005) showed that travel is not always a derived demand and that travel may be desired for its own sake alone. This has been shown in the growing body of research in the concept of ‘excess travel’, where commuters willingly choose longer journeys despite a shorter or more direct option being available (Mokhtarian & Salomon, 2001).
Journeys have been shown to provide additional amenity and productivity benefits beyond utilitarian transport. These benefits can be broken into two streams: passive enjoyment of travel (such as relaxation and enjoyment of nature), and active enjoyment (the use of productive time such as conducting work on the journey). Travel modes have also been identified as being more or less inclined to exhibit excess travel. As expected, pedestrian and cycle journeys are commonly associated with excess travel (Ory & Mokhtarian, 2005; Morris & Guerra, 2014), where interacting with and enjoyment of the environment and exercise and relaxation are most commonly cited as reasons for excess travel. Car travel has been less associated with excess travel, as users are still usually more concerned with minimising their commute time, the only benefits being derived are those of enjoying the process of driving (Stradling et al., 1998; Stradling et al., 2000; Mokhtarian & Salomon, 2001).

It has also been suggested that public transport modes encourage excess travel in some circumstances. However, most of the research in this area has relied on stated preference surveys which assessed users’ perceptions of travel modes and how they choose modes. Users’ perceptions of public transport are included in studies that have attempted to gather opinions on choosing modes based on factors other than travel time and reliability (i.e. instead in terms of comfort and amenity), and which have gathered data such as opinions on comfort of ride, crowdedness, and other amenity related issues which have impacted on people’s choice of mode (Redmond & Mokhtarian, 2001; Ory & Mokhtarian, 2005).

Further studies have also started to shed light on what activities, such as working, users are participating in on public transport, assessing whether the journeys are conducive to working (Lyons & Urry, 2005; Lyons et al., 2007; Jain & Lyons, 2008). For example, rail journeys have been seen as having less lateral movement than buses and therefore are seen as being more conducive to doing work (Lyons et al., 2007). Of course the ability to have a seated journey is also a contributing factor, not only in comfort terms, but in the ability to be able to conduct work on the journey. By gathering this data, these studies have begun to suggest that public transport modes may be assessed differently in these terms of amenity, rather than solely in terms of long accepted public transportation indicators such as travel time and reliability.
Such acknowledgements have led to another noticeable shift in transport planning, from only trying to reduce travel times to a renewed focus on improving the quality of transport services. Such efforts can be seen in current practice of improving on-board facilities such as more comfortable seating and technologies such as Wi-Fi and power charging outlets on New York City buses (MTA, 2016) and licensed eateries available on the London Thames ferry service (MBNAThames Clippers, 2016b). In many cases the intent is to make public transport more attractive so as to entice travellers away from private car use. Whether this effort has been successful, or whether these investments only benefit existing users, is still being debated. However, there is some literature showing that with better amenities on board users perceive their travel to be shorter and less burdensome (Lyons & Urry, 2005). Jain & Lyon (2008) also show that while passengers on short distance trips do not value amenities so much, as travel times increase and the potential for productive use of the time increases, these amenities become more important in the user’s perception of the transport mode (Jain & Lyons, 2008, p.86).

It has been suggested that urban ferries are one mode of public transport that provide these additional benefits. Surveys of users have found that commuting passengers value the natural environment and these surveys also highlight the potential for the mode to provide a more amenable journey (Weisbrod & Lawson, 2003; Thompson et al., 2006). However, there has so far been no empirical study that has tested this hypothesis by comparing travel modes in a public transport network. As will be shown, recently available public transport smart card transaction data has opened up new possibilities for such analysis.

1.12 Styles of planning

Whilst the above discussion has highlighted issues around what variables are included in transport planning and how those variables are conceived, it has not yet considered what types of planning actually occur (beyond technical-rational planning approaches) in terms of the actual practice of planning by bureaucrats, politicians and other actors in the planning process. We turn to this issue now. Like the shift toward the redefined goal of sustainable mobility and accessibility in values and objectives in transport planning, the transport planning process itself has also evolved. With a greater interdependence of interests from stakeholders and other participants now evident in the planning process, transport planners
often today assume a more facilitative role in formulating solutions. In a study of contemporary transport planning processes, Innes and Gruber (2005) observed four distinct planning styles in transport planning: technical/bureaucratic, political influence, social movement and collaborative (Figure 3). They observed that, depending on the diversity of interests and the interdependence of these interests, the planning styles would vary in each context (Innes & Gruber, 2005).

A low diversity of interests and low interdependence of interests lends itself to a traditional technical analysis whereby the planner systematically chooses the best option from available data to decide on one of a limited number of options. Sager (2009) identifies a similar ‘instrumental synoptic (rationalistic)’ style where the planner “chooses the bundle of instruments that gives the highest achievement of the given goal(s)” (Sager, 2009, p.39).

**Figure 3:** Four styles of planning: Conditions for their use and their theories of change

Source: (Innes & Gruber, 2005, p.186)
Political influence occurs when there is a high diversity of interests but low interdependence of interests. This planning style is characterised by a political champion co-opting peers into their particular view. Politicians and other decision makers are cognisant of the desires of their constituents and seek to provide accordingly to gain political support. These political motivations can lead to beneficial outcomes where public support leads to the formation of urban growth coalitions coalescing around the specific urban investments that they see value in supporting (Logan & Molotch, 1987). Such examples in transport include lobbying for public transport investment, leading to the formation of key policy platforms of politicians seeking (re)election. In some cases, a see-and-replicate model where a delegation of bureaucrats sees that a potential solution in another city has been shown to be influential in the implementation of transport technology transfer in cities, such as in Brisbane’s busways (Tanko & Burke, 2013), and as will be shown in ferry systems in London and New York. These cases also showed strong political championing through supportive bureaucrats committed to the political leader’s ideas. As noted above, policy entrepreneurs can also often see wider potential in public transport issues in order to achieve their other objectives, such as promoting economic growth.

On the other hand, such political motivations can also lead to poor outcomes where transport projects encounter difficulties and end up delivering sub-optimal outcomes. In this case political championing of a cause that one believes in (perhaps in isolation and/or irrationally) can lead to bad choices that, in turn, lead to disastrous transport outcomes (see Hall, 1982). An example of this situation can be explained by the concept of public choice theory to explain government policy intervention. Hall (1980) notes that producers of public goods (i.e. those who build transport systems) will be active in seeking to sway government investment. They will be:

...better informed than consumers. And governments will tend to favour producers more than they do consumers. The net result is that the mix of public goods and services will be far from optimal in an economic sense.... This arises partly from the ignorance of politicians and governments about what their individual voters actually want. (Hall, 1980, p.226).
Most policy interventions in public transport identify a problem that a government policy seeks to correct. This may be the case of a lack of public transport service which the market does not provide. However, public choice theory highlights that public interventions are also prone to failures and, as noted above, are prone to the self-interest of politicians. The public also has less information than the market does, so this can lead to less equitable outcomes than the policy sought to correct in the first place (Boyne, 1998).

Social movements occur when a citizen group organizes to propose plans in the community interest, either as one committee group or as a collaboration between a number of organisations. This union often has considerable power to influence decisions and shape policy outcomes. Finally, collaborative planning involves a co-evolving process whereby all actors cooperate to solve an issue. This occurs when there is a high diversity of interests and also a high interdependence of interests. However, this process is also the most difficult to make work, especially in cases where those in existing positions of power are unfamiliar with the process and/or are unwilling to give up any of this power to create a more equitable and consultative planning process.

While many water transport systems have a long history of operation in cities, the configuration of modern urban ferry systems are in many ways unfamiliar. We currently do not know much about the planning processes that were involved in the decision making process to develop an innovative transport mode. In many cases such innovations in transport have resulted not from a sudden implementation of policy, but instead from a step-by-step iterative development process that in many ways mirrors more general product development literature. In terms of innovations, specifically in transport planning, Feitelson and Salomon (2004) suggest a political economy approach where three preconditions reflecting the feasibility of a project need to be met to facilitate a transport innovation (Feitelson & Salomon, 2004, pp.11–12). The first precondition is techno-economic feasibility, with a need for not only the ability of a proposal to technically work, but also the ability for it to compare favourably in a CBA to show that it is economically viable. The second precondition is social feasibility showing that the public is likely to accept the proposed innovation. The third precondition is political feasibility, wherein politicians must consider public perceptions and other interest groups. Currently, we do not know the process behind the implementation of an urban ferry system and whether the decision makers have followed such a path. Whether this
necessitates a change in planning style to incorporate a change in transport modes is also uncertain. The current research seeks to address this issue and provide an initial understanding of how such systems have been implemented and what value they have contributed.

1.13 Path dependencies

As will be discussed in Chapter 6, the capacity of cities to implement transport policies depends largely on the context of each transport network and the history of transport planning in each city. Path dependencies are one way of understanding how past progress can indicate future plans and possible limitations. Path dependencies are defined as “historical sequences in which contingent events set into motion institutional patterns or event chains that have deterministic properties” (Mahoney, 2000, p.508). Pflieger et al. (2009) identify three type of development paths in urban policies. First there are reproduction paths, which signify ‘business as usual’. Such cases often display difficulties in changing paths due to strongly embedded private interest groups and a lack of political will and leadership to overcome such parochial interests (Pflieger et al., 2009). For instance, Bangkok has a long history of ad hoc private sector led transport planning projects. In cities with a lack of formalised planning such as this, efforts to implement new processes are often counteracted by the entrenched coalitions of private actors who have historically shaped transport policy. This lack of capacity is often demonstrated when efforts to transfer transport policies fail to consider local context and end in failure.

Secondly, innovation paths occur via a recognition of the failure of existing systems and the will to introduce new and improved policies. In such cases, recognition of social and ecological limitations may bring about a process of ecosocialisation, where capitalistic goals are adapted toward a greater focus on social and environmental outcomes (Low & Gleeson, 2001). As will be discussed, cities with these characteristics have found it easier to adapt in such ways as providing for personal mobility and/or incorporating more sustainable transport options. Despite this general trend, a renewed focus on infrastructure is also currently evident and this can nevertheless impede such innovations and serve to further entrench existing focus on large scale megaprojects (Low & Gleeson 2001; Dodson 2009), thereby continuing a reproduction pathway. The final possible pathway is contingency, where specific events
rapidly change the course of development. Such an example would be the creation of a new technology or transport operating model.

1.14 Modernisation of transport

Many cities, particularly in the developing world, are facing the challenges of implementing policies to modernise their existing legacy transport systems. These systems are often underdeveloped and are seen negatively, which runs counter to the developmental aspirations of the developing country (Rimmer, 1986), with little opportunity for these services to be modernised. Furthermore, Richmond (2005) highlights that proposed transport systems are often weighed in their existing forms, with no opportunities for modernised services to demonstrate their value. An example of this is the conception of buses as being slow and uncomfortable. Such views are also applicable to many indigenous urban ferry systems, which are often seen as being obsolete when compared to modern rail and other land based modes. However, in the case of modern bus services that are given their own right of way, with upgraded on-board facilities and less polluting propulsion systems, the perception can change to one that sees buses as offering a comfortable high speed and high-capacity public transport option (Hoffman, 2008; Tanko & Burke, 2013).

In the case of urban ferry systems there are a range of services, from modern custom built catamarans in Brisbane, to the slower utilitarian vessels in Bangkok which have not changed since their introduction in the 1970’s. Older technology and safety concerns in Bangkok give the impression of underdevelopment, which has further impeded their development (Hossain & Iamtrakul, 2007). However, like the modernisation of bus services, such development may occur in water-borne transport services. As noted previously, though, the preference for modern rail services can stifle efforts to modernise existing transport services. Strong political lobbies for existing transport systems may also be to blame for processes that tend to favour the replication of existing forms, preventing the modernisation of other currently underdeveloped modes. Naess (2006) also observes that these decision making processes are often biased against the poor and future generations. Further complicating the case for the modernisation of water transport is the suggestion that some contemporary urban ferries may be the opposite of underdeveloped and even considered a ‘transport of delight’ i.e. in place more for show and political reasons than for useful transport purposes (Richmond, 2005).
However as will be shown in Brisbane, the ferry system which began as a small scale transport service with benefits for the city’s image and for tourism, has now evolved to become a key part of the modern commuting system.

1.15 Ferry research needs

Currently there has only been limited research into contemporary ferry systems. This has included suggestions of the value they may contribute to cities in transport and economic functions (Weisbrod & Lawson, 2003; Thompson et al., 2006). There is little extant research on how systems have been implemented, or assessment of whether or not existing systems have achieved their goals. For example, was CBA or technical analysis used to justify decisions and does this reflect the eventual role the urban ferry system has played? Or were political processes and instinctive decision making more at play? Currently, we do not know how users are actually using these systems, and therefore whether the transport function that was intended has been reflected in reality, or whether other factors are more important in the success of such systems. Such unknowns open up the need for exploratory research to investigate a range of questions that emerge from this discussion. Firstly, there is a need to understand how systems are planned (including in terms of styles of planning), what sets of benefits are driving investment decisions, how these systems perform and are used, and whether excess travel exists in urban ferry systems. Furthermore, with the availability of smart card transaction data, we can now empirically assess patronage and provide an analysis of how ferries are being used. By looking at these travel patterns we can answer some of these questions and find what value an urban water service provides to a community, i.e. is it simply a tourist service or is it a commuting service which is used daily? This thesis seeks to answers these questions and fill these gaps in the literature.

1.16 Characterisation of urban ferry systems

As previously noted, the redevelopment of urban waterfront areas and the decline in industrial functions have led to options for operating urban ferry systems. The favoured option until recently however has been bridges or tunnels with ‘bridge cities’ even becoming commonplace such as in Portland, USA and Brisbane (Wortman et al., 2006; Brisbane City...
But increasingly rivers are instead being seen as an opportunity to be harnessed as an extra urban highway. In the United States, currently investment in ferry technology is at its highest where ferry services have resumed in both the East River and Hudson River in New York. The San Francisco Bay Area Water Transit Authority has also initiated a Water Transit-Oriented Development program (WaTOD) (San Francisco Bay Area Water Transit Authority, 2002). However, emerging contemporary urban ferry services are different from those used previously. Whereas historically services operated for solely utilitarian purposes, ferries are now being used for commuting, leisure and tourist trips (Weisbrod & Lawson, 2003), and as well, they are being patronised by different user groups. Coinciding with inner city gentrification and the redevelopment of riparian areas, patrons are increasingly white collar workers. Finally, and significantly for this thesis, the operating models are vastly different (Thompson et al., 2006).

One of the most significant operational changes is what Thompson et al. (2006, p27-30) refer to as parallel ferry services, which run along a coastal area or river bank with multiple stops at places of interest. This is a major change from traditional ferry services, whose sole purpose has been usually to carry passengers back and forth between two points across a river or bay. As noted previously, the advancement of technology has also permitted the increase in speed of these services, making them an efficient and competitive public transport mode, in many cases rivalling the travel times of urban train and bus services (Weisbrod & Lawson, 2003). However, apart from a few services currently operating in select cities (Brisbane, New York, London, Copenhagen, Gothenburg, Hamburg and Bangkok) the presence of urban ferry systems is still rare. Moreover, what is known about these services and their application is to date lacking in the literature. The potential for these ferries to become an innovative and ultimately useful urban transport solution has largely been unexplored thus far.

There have been only a few studies which have researched these systems. In a study looking at their feasibility in comparison to other modes, Thompson (2006) concluded that other factors needed to be considered for such systems to be feasible. These include additional terminal and on board facilities to promote shopping and other activities. The benefits of urban ferry systems have also been highlighted. Weisbrod and Lawson (2003) note the comparatively pleasant and comfortable public transit trip as compared to other transit
modes. They identify the potential for urban ferry systems to be a catalyst for urban regeneration in American cities (Weisbrod & Lawson, 2003).

Other research has shown that the cost of implementation is relatively modest because there is no track building required, as open water thoroughfare is readily available. This also aids in disaster relief circumstances. For example, this cost and route flexibility were advantageous in the immediate aftermath of Hurricane Sandy in New York where ferries were the first service back in operation, providing relief to other affected services (Burke & Sipe, 2013). Finally, the infrastructure including vessels and terminals can be repurposed and the losses of the project can be minimised using a contingency plan if a system is not successful (Thompson et al., 2006).

On the other hand, disadvantages have also been highlighted, such as the observations that travel times are slower. However, as highlighted previously the concept of travel time reduction is increasingly being questioned. It has been shown in surveys of urban ferry systems that when confronted with a more comfortable travelling experience, travel time is not such an important factor for commuters (Weisbrod & Lawson, 2003). Finally, there is the critique that an indirect route and distance of travel is not competitive with other public transport. Recent configurations of ferry services have begun to address this issue as they cater more towards public transport functions in the form of incorporating a linear route service, similar to the routes of other public transport modes.

Contemporary urban ferry systems are often therefore operating in different configurations than in the past. This research is focused on such systems that fit the operating model and the specific characteristics highlighted below, which form the scope of the study. Such contemporary urban ferry systems incorporate:

- **Linear route.** There are many traditional ferry services that are simply cross river services. However cross river services will only be studied in the capacity that they contribute to the network of the ferry system and public transport network as a whole. The focus of this study is predominantly on linear up-river/down-river parallel routes.
• **Urban scale.** Only ferries that are operating solely within urban and peri-urban contexts are within the scope of this research. Long haul intercity and inter-country services are not included, except where transfer and network issues are relevant.

• **Public transport with multiple stops.** The ferry systems must be mainly passenger based public transport with a defined timetable and ticketing system. Demand based ferry services and water taxis are not included. Freight and services are also excluded.

Table 3 shows a selection of urban linear ferry services which are currently in service throughout the world and which meet these criteria. Sites have been selected as per the definition above.

<table>
<thead>
<tr>
<th>City</th>
<th>Description</th>
<th>Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brisbane</td>
<td>CityCat (St Lucia to Northshore Hamilton)</td>
<td>Transdev (Veolia Transdev Australia)</td>
</tr>
<tr>
<td></td>
<td>City Hopper (North Quay to Sydney Street)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cross River Ferry (Bulimba to Teneriffe)</td>
<td></td>
</tr>
<tr>
<td>New York</td>
<td>East River Ferry (E 34th Street Midtown to Wall Street Pier 11)</td>
<td>NY Waterways</td>
</tr>
<tr>
<td>London</td>
<td>London Thames Clippers (Putney Pier to Woolwich Arsenal Pier)</td>
<td>Thames Clippers</td>
</tr>
<tr>
<td>Copenhagen</td>
<td>Copenhagen Harbour Buses Det Kgl. Bibliotek &quot;Royal Library&quot; to Nordre Tolbod &quot;Northern Customs Point&quot;.</td>
<td>Movia</td>
</tr>
<tr>
<td>Gothenburg</td>
<td>Stena Line Gothenburg (Alvsborg Castle to Lilla Bommens Hamn)</td>
<td>Alvstaden Goteborg</td>
</tr>
<tr>
<td>Hamburg</td>
<td>Hafencity to Blankenese</td>
<td>HADAG HVV Hamburg</td>
</tr>
<tr>
<td>Bangkok</td>
<td>Chao Phraya express (Pakkret to Rajburana)</td>
<td>Chao Phraya Tourist Boat Co, Nonthaburi</td>
</tr>
</tbody>
</table>

**Table 3.** Currently operating urban ferry systems
1.17 Brisbane CityCat system

The case of Brisbane provides a useful example of the evolution of a contemporary ferry system in a river city. Historically, Brisbane possessed a number of cross river ferry services dating as far back as 1943 (Royal Historical Society of Queensland, 2005). However, it was the introduction of a linear based ferry service that subsumed existing services into a parallel service that now defines Brisbane’s urban ferry system. The first high speed CityCat vessels were introduced in Brisbane in 1996 (Figure 4).

![First generation CityCat, initially four were introduced in 1996. Source: Tanko (2016)](image)

Four vessels were initially introduced, however, with growing demand two more were introduced later that year, with two more subsequently added in 1998, leaving a total of 8 vessels operating by 1998. The service operates from 5am-11pm every day, and until 12.30am on Friday and Saturday nights (Translink, 2016).
The CityCat service has been popular in the public transport network, given Brisbane’s subtropical climate and the outdoor seating options (Sipe & Burke, 2010). Table 4 shows how the system has grown until the present. The network has also grown spatially as additional stops have been added further along the river. Currently, the network extends from The University of Queensland through to Hamilton, with a total of 24 stops (Figure 5). There are three types of ferry services in operation, as explained below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total CityCats in service</th>
<th>Passengers (millions)</th>
<th>% change</th>
<th>Average daily passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>6*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>10**</td>
<td>5.43</td>
<td>15.65%</td>
<td>14,871</td>
</tr>
<tr>
<td>2008</td>
<td>13</td>
<td>6.28</td>
<td></td>
<td>17,199</td>
</tr>
<tr>
<td>2015</td>
<td>21</td>
<td>7.12</td>
<td>13.41%</td>
<td>19,506</td>
</tr>
</tbody>
</table>

* Capacity of 149 passengers (CityCats introduced 1996-1998)
** Capacity of 162 passengers (CityCats introduced 2005-present)

**Table 4:** CityCat fleet and ridership growth. Sources: (Sipe & Burke, 2010; Transdev Brisbane Ferries, 2014; Queensland Government, 2015)

1. **City Cat linear route** (St Lucia to Northshore Hamilton). Blue route. Fast ferry service that traverses the entire length of the network and uses larger catamaran vessels as shown in Figure 4. There are slight differences in capacity between the older vessels and the newer generation CityCats, ranging from a capacity of 149-162 passengers (Transdev Brisbane Ferries, 2013). The total number of CityCats is now 18. These vessels have a top speed of 25 knots and feature open-air standing and seating areas outside. The service stops at most major destinations; however, it does bypass some smaller inner city stops. In effect the service runs express through the inner city in order to minimise travel times. The remaining stations in the inner city are serviced by the City Hopper ferry service.

2. **City Hopper linear service** (North Quay to Sydney Street). Red route. This service complements the CityCat service by offering an inner city network connection to
terminals that the CityCat service does not stop at. This service uses smaller single hull vessels with a capacity of 54-80 passengers. There are currently 9 vessels in the fleet. They run at a more leisurely pace of 8-12 knots. City Hoppers are easily recognisable by their distinctive red colouring (Figure 6). These services are also free for all passengers.

![CityCat Network Map](image)

**Figure 5.** Current CityCat network map. Source: Adapted from Translink, 2016

3. **Cross River Ferry** (Bulimba to Teneriffe). Yellow route. A traditional cross-river only service is available between a number of high demand terminals on opposite sides of the river. This includes a three stop service running in the inner city between the popular destinations of Thornton Street, Eagle Street Pier and Holman Street (Translink, 2013). There are also two other destinations which stop on each side of the river. These are the Teneriffe-Bulimba and New Farm Park-Norman Park services, destinations which also serve as important transfer points for ferry services and other modes (Soltani et al., 2015).
These individual routes and services are planned as an integrated network which allows passengers to reach any destination on the network with transfer options available at key terminals. The operation of the services is contracted out to a private company by tender, however, network planning and ticketing are maintained by the regional public transport authority, Translink (Sipe & Burke, 2010). This allows integration with other modes of transport which are also part of this multimodal network. A significant contributor to the success of this integration was the introduction of the region wide ‘Go-Card’ smart card, which allows free transfers between all public transport modes (Soltani et al., 2015).

Despite their popularity, revenue is insufficient to meet operating costs and the services are subsidised by the Queensland Government and the Brisbane City Council. In 2009/2010 the systems’ operating expenses were approximately US$29m, with revenues of only US$16m (Newman, 2010; Brisbane City Council, 2010). Most of this revenue was from fare box revenue from the 6.7 million passengers who travelled on the ferries that year. The subsidy offered per passenger by Brisbane City Council was approximately $US1.50. The Queensland Government provides further average subsidy data for all public transport modes.
and it shows that the ferry service is provided with a modest subsidy compared to other modes, in particular the rail network (Queensland Government, 2015). It is worth noting that the ferries were initially implemented largely as a tourism measure and to replace existing cross-river links in a more efficient structure (Sipe & Burke, 2010; Tanko & Burke, 2015). However, they have since evolved to cater for a variety of trip purposes; in particular they now serve as an important public transport link for residents and commuters, with approximately 17,000 passengers using the ferry service each day. Weekend recreation and leisure trips are also significant (Soltani et al., 2015).

1.18 Unsuccessful urban ferry systems

At this point it is worth mentioning that there have been a number of unsuccessful urban ferry initiatives. In London, before the success of the current service, there were a number of failed attempts to implement such a service. The most prominent was the River Bus initiative which cited a number of factors contributing to its failure including lack of sufficiently developed waterfront precincts (including the now densely populated Docklands area) and difficulty in accessing piers which varied in ownership at the time. The Pasig River in the Philippines has also had many attempts to implement a passenger service to expand transport options in congested Manila. While initial attempts were thwarted by water quality issues, after rehabilitation efforts, a subsequent service also failed due to factors such as poor timetabling, confusing passenger information, and financial mismanagement (Utomo & Mateo-Babiano, 2015). Evidently, much can potentially be learned from such failures as the factors contributing to successful systems and where relevant lessons from such examples will be highlighted in the research that follows. However, most focus remain on successfully systems and as such the papers that follow may give an overly positive view of such schemes and their ease of implementation.

1.19 Research paradigm and aims

As shown, despite an increasing presence little is known currently about contemporary urban ferry systems. The research aim of this thesis is to explore how such systems are being
planned and used. This study also proposes to assess whether ferries offer something different to other transport modes and whether they offer a premium service. Finally, the research asks what the future of water transit is in cities: what are the facilitators and barriers to use and how can such systems be planned for the future? To achieve these aims, this research employs a mixed methodology of quantitative and qualitative research to reveal why such systems are being implemented. Therefore, in undertaking the research surrounding the motivations for implementing such systems, a constructivist approach is used in order to question the realities of personal decision making behaviour and to suggest interpretations. There is little literature available in this area, and this study is exploratory in nature. The research did not take so much of a paired comparison due to this reason, such as by comparing the Sydney/Paramatta service to Brisbane for example. Such an approach may have offered potential advantages, but given that so little is currently know about these systems as a whole, it was decided that a broader comparison of a wide set of international examples would offer more. In this way the ontological view changes to multiple realities based on personal motivations, political factors and other explanations that are drawn from in depth interviews with key actors in the transport planning processes in each city. An interpretivist epistemology is used to gain an understanding of the reality that planners have experienced in their motivations for implementing certain transport policies. The research then uses an inductive method to establish theory based on this policy analysis and expert interviews.

In chapters using quantitative methods a different research paradigm is used. It is acknowledged that travel patterns exist and do not need interpretation, and so identifying usage travel patterns takes on a more post-positivist ontological approach in empirically documenting the use of urban ferry systems. Through analysis of smart card transaction data, it is possible to test theories of how systems are used via data manipulation and visualisation. Also a hypothesis was established that excess travel was present and the research method was organised to test this theory. In this way, a post-positivist ontology and empiricist epistemology is used. In this case, there is existing data and theories that can be developed based on existing literature on how people travel and the results can be modelled, therefore theory is developed in a more deductive manner.
1.20 Research questions

The research questions that will be addressed in this program of research are summarised in Table 5, organised by each activity that will be reflected in the thesis chapters that follow. The defined scope of the urban ferry systems being studied is then summarised in Table 6.
<table>
<thead>
<tr>
<th>Activity</th>
<th>Research questions</th>
<th>Background Studies</th>
<th>Methods</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Brisbane case study</td>
<td><strong>Primary question</strong></td>
<td>(Sipe &amp; Burke, 2010)</td>
<td>Qualitative interviews</td>
<td>Tanko and Burke (2015)</td>
</tr>
<tr>
<td></td>
<td>Why was the Brisbane linear ferry system installed and what were the preconditions politically, socially and environmentally?</td>
<td>(Burke &amp; Sipe, 2013) (Tanko &amp; Burke, 2013)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Feitelson &amp; Salomon, 2004)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. International comparative review</td>
<td><strong>Primary question</strong></td>
<td>(Burke &amp; Sipe, 2013)</td>
<td>Qualitative interviews</td>
<td>Tanko and Burke (2016)</td>
</tr>
<tr>
<td></td>
<td>What were the contributing factors to each system being implemented, what functions do they currently serve and what are the system characteristics and metrics?</td>
<td>(Currie &amp; Burke, 2013) (Currie et al., 2014)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Innes &amp; Gruber, 2005)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>(Innes &amp; Gruber, 2008)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Tanko, 2013)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Secondary questions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Why was this system installed?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- What was the historical context?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- What is the operating model of services and patronage?</td>
<td></td>
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</tr>
</tbody>
</table>
### 3. How is a typical system being used?

**Primary question**
How is the ferry service being used in Brisbane and what type of trip patterns are evident in users?

**Secondary questions**
- What origins/destinations are most popular?
- How are users accessing terminals?
- Are users transferring between modes?
- What is the difference between on and off-peak travel?

(Sipe & Burke, 2010)  
(Burke & Sipe, 2013)  
(Blythe, 2004)  
(Bagchi & White, 2005)  
(Agard et al., 2006)  
(Morency et al., 2006)  
(Trépanier et al., 2007)  
(Park & Kim, 2008)  
(Ma et al., 2013)  
(Zuniga et al., 2013)

Quantitative smart card data analysis
Soltani et al. (2014)

### 4. Why do people choose ferries?

**Primary question**
Is there a ‘premium’ attached to using water transport? Do users demonstrate excess travel when using urban water transit compared to other modes?

(Weisbrod & Lawson, 2003)  
(Thompson et al., 2006)  
(Yen et al., 2015)

Quantitative smart card data analysis
Tanko et al., 2016a
5. What is the future of water transit?

<table>
<thead>
<tr>
<th><strong>Primary question</strong></th>
<th>(Sipe &amp; Burke, 2010)</th>
<th>Qualitative interviews</th>
<th>Tanko et al., 2016b</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is water transport’s role in urban transport, and how can systems be planned and operated to provide another option within a public transport network?</td>
<td>(Burke &amp; Sipe, 2013)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Hossain &amp; Iamkrakul, 2007)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(Thammasat University, 2015)</td>
<td></td>
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</tr>
</tbody>
</table>

**Secondary questions**

- What are the facilitators and barriers to implementing such systems?
- How can water transport be integrated in existing and future planner transport networks?

**Table 5: Research framework**
<table>
<thead>
<tr>
<th>Within scope</th>
<th>Outside scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban scale</td>
<td>Non-urban including peri-urban, rural and regional.</td>
</tr>
<tr>
<td>Intra-city</td>
<td>Inter-city</td>
</tr>
<tr>
<td>Linear ferry</td>
<td>Only cross river ferry</td>
</tr>
<tr>
<td>Passenger transport ferry only (including bicycles, wheelchairs and other personal transport aides)</td>
<td>Cargo-based or ferries transporting goods primarily. i.e. not primarily passenger transport</td>
</tr>
<tr>
<td>Relatively short distance</td>
<td>Long haul distances (perhaps linking entire coastal regions and countries)</td>
</tr>
<tr>
<td>Regularly scheduled services</td>
<td>Water taxis that are demand-based</td>
</tr>
</tbody>
</table>

**Table 6:** Ferry systems within and outside of scope for research

### 1.21 Approach and methods

This proposed research was completed in five discreet pieces of work incorporating a mixed method approach of both quantitative and qualitative data, depending on the activity that was conducted. Table 7 summarises the methodology that was used for each activity. Activity 1 firstly consisted of archival reviews of relevant planning documents surrounding the introduction and operations of the modern urban ferry system in Brisbane in the period 1991-2015. Interviews with key actors in the planning process at the time, including government officials, private planning consultants and independent scholars were conducted via a snowball recruitment method. Interviews were conducted in a semi-structured format in order to construct a narrative of the processes and key events that led to the formation of the concept of the urban ferry system, through to its development and implementation.
<table>
<thead>
<tr>
<th>Activity 1 Brisbane case</th>
<th>Activity 2 International comparison</th>
<th>Activity 3 Usage patterns</th>
<th>Activity 4 Excess travel analysis</th>
<th>Activity 5 Future ferry planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research type</td>
<td>Qualitative</td>
<td>Quantitative</td>
<td>Quantitative</td>
<td>Qualitative</td>
</tr>
<tr>
<td>Research paradigm</td>
<td>Positivist ontological</td>
<td>Constructivist ontology</td>
<td>Constructivist ontology</td>
<td>Positivist ontological</td>
</tr>
<tr>
<td></td>
<td>Empiricist epistemology</td>
<td>Interpretivist epistemology</td>
<td>Interpretivist epistemology</td>
<td>Empiricist epistemology</td>
</tr>
<tr>
<td></td>
<td>Deductivist theory</td>
<td></td>
<td></td>
<td>Deductivist theory</td>
</tr>
<tr>
<td>Methodology</td>
<td>Archival review/interviews</td>
<td>Travel data analysis</td>
<td>Travel data analysis</td>
<td>Travel data analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Logistic regression choice</td>
</tr>
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<td></td>
<td></td>
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<td></td>
<td>modelling</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Participants and</td>
<td>6 key transport planners/government officials via snowball recruitment</td>
<td>Trip-makers on SEQ public transport services in the period November 2012-April 2013</td>
<td>Trip-makers on SEQ public transport services in the period November 2012-April 2013</td>
<td>5 key transport planners/government officials via snowball recruitment</td>
</tr>
<tr>
<td>recruitment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample size</td>
<td>6</td>
<td>1,672,581 records</td>
<td>13,745 records</td>
<td>5</td>
</tr>
<tr>
<td>Key analysis</td>
<td>Innovation theory to explain linear urban ferry system development in Brisbane</td>
<td>Contextual basis for urban ferry systems worldwide and systems comparison</td>
<td>Usage patterns of linear ferry passengers</td>
<td>Hypothesis of excess travel confirmed in urban ferry system users</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Planning for future water transit in cities</td>
</tr>
</tbody>
</table>

**Table 7**: Research methodology of each component of thesis
Activity 2 largely used the same methodology, however the recruitment process was expanded to include international perspectives in each context where the respective ferry system was operating. All interviews were conducted in English and were analysed.

Activities 3 and 4 involved a shift to a quantitative approach with the use of a sample of 6 months of transaction smart card data for Brisbane, Australia. To prepare the data the process first involved data cleaning to remove errors and incomplete records. Each data sample was then filtered to include the variables needed for the analysis for each activity. Activity 3 involved manipulation of the data to provide insight into usage patterns of the CityCat ferry system in Brisbane. Activity 4 used a logistic regression choice model to compare bus and ferry journeys. Data was queried using SPSS 23 and was mapped in ArcGIS 10.2. The specific variables that were included and additional variables that were calculated are included in the description of the methodologies in Chapters 4 and 5. Finally, Activity 5 in Chapter 6 used a similar methodology to Activities 1 and 2, except the research was conducted in Bangkok, Thailand with the assistance of local collaborators at the Facility of Architecture and Planning, Thammasat University, Rangsit. All interviews were conducted in Thai and were professionally translated to English for analysis.

1.22 Ethics

This research was approved for ethical clearance GU Ref No: ENV/04/14/HREC. This was a low risk approval mainly to conduct interviews with planners and politicians regarding transport planning processes in a number of cities where the research was conducted. There were nil adverse effects or ethical concerns reported during the research.

1.23 Dissertation structure

This thesis consists of seven sections including an introduction and background and five results chapters. The results chapters are in the form of published and in review manuscripts formatted to meet the requirements of the peer reviewed academic journals that they have been submitted to. There are also detailed literature reviews at the start of each results chapter in accordance with the requirements of journal manuscripts. As a result, there is some
repetition among the results chapters, including in the descriptions of study sites and reference lists. The separate reference list for each chapter is included at the end of each chapter. The final chapter incorporates a general discussion, and serves to synthesise the research findings in relation to the research aims and questions. Implications of the research findings are discussed, as well as the overall strengths and limitations of the research. Finally, future research needs are suggested. The thesis was prepared in accordance with Griffith University’s policy of including research papers in a thesis. This policy has been provided for reference in Appendix A. The structure can be visualised as below, where the research theory and aims highlighted above have guided the presentation of the thesis.
Urban ferry systems: contemporary planning, development and use of water-based transit in cities

### Chapter 1: Introducing ferries in Brisbane, Australia

### Chapter 2: Emergence of water transit systems worldwide

### Chapter 3: Analysis of ferry travel patterns

### Chapter 4: Choice modelling of ferry and bus journeys

### Chapter 5: Prospects for water transit under transport modernisation

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**Figure 7. Dissertation structure**
2 Innovation and transport planning: Introducing urban linear ferries in Brisbane, Australia

Chapter 2 begins by providing an overview of how one representative linear ferry system was implemented as an innovative addition to a city’s transport network. This paper was the first piece of research from which all subsequent work followed, as it sets the basis for the first critical analysis of the circumstances underpinning such transport planning developments. The key aim of this paper was to establish how ferry systems are viewed and actually planned for. Interviews with key actors involved in the planning and implementation of the system were conducted to shed light on the planning of an operation of such systems. The contribution of this paper is the first planning study of the urban linear ferry system in Brisbane, Australia.

The work presented in Chapter 2 was previously published in State of Australian Cities Conference Refereed Proceedings 2015 as “Innovation and transport planning: Introducing urban linear ferries in Brisbane, Australia” by Tanko, M. & Burke, M. I., 2015.
STATEMENT OF CONTRIBUTION OF CO-AUTHORS TO PUBLISHED PAPER

This chapter includes a co-authored paper. The bibliographic details of the co-authored paper, including all authors, are:


The authors listed below have certified that:

1. They meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
2. they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
3. there are no other authors of the publication according to these criteria;
4. potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
5. they agree to the use of the publication in the student's thesis and its publication on the Griffith University database consistent with any limitations set by publisher requirements.

<table>
<thead>
<tr>
<th>Contributor</th>
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<tbody>
<tr>
<td>Michael Tanko</td>
<td>Preliminary conceptualisation of the approach and method for the research with Assoc. Prof. Burke; carrying out of all archival document analysis and interviews; significant revision and review of the final paper submission.</td>
</tr>
<tr>
<td>5 December 2016</td>
<td></td>
</tr>
<tr>
<td>Matthew Burke</td>
<td>Provided assistance in the theoretical framing of the research and the writing of paper revisions and the final manuscript.</td>
</tr>
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</table>

Principal Supervisor Confirmation

I have sighted email or other correspondence from all co-authors confirming their certifying authorship.

Matthew Burke
Research questions addressed in this paper and contributions

Primary question

Why was the Brisbane linear ferry system implemented and what were the preconditions behind such an innovation, politically, socially and environmentally?

Summary of contributions

First analysis of the political and planning process that were significant in the implementation of the CityCat urban ferry system in Brisbane, Australia in the 1990s.
Innovation and transport planning: introducing urban linear ferries in Brisbane

Michael Tanko¹ and Matthew Burke¹
¹Urban Research Program, Griffith University

Abstract: Brisbane’s CityCat ferries have become a successful fixture within the city’s public transport system. The system has grown from an initial fleet of four catamaran vessels in 1996 to 21 vessels today. It features an urban scale, a passenger focus, regular scheduling, high speed vessels, a linear route configuration with multiple stops along the river and distinct branding and marketing. Cities elsewhere have since created similar systems. This paper uses innovation theory, derived from the product development literature to help explore how this innovation in the public transport market occurred. A focus was on the development of the CityCat system during the period between 1990 and 2000, a time of significant transformation of the riverine environment in Brisbane City. Six interviews were conducted with key actors involved in the planning and early operation of the ferry system. The results suggest that previous ferry operators with grounded local knowledge and strong economic motivations were central to the preliminary genesis of the concept, but that policy entrepreneurs in local government, harnessing the ferries to a planning agenda around a ‘River City’ and urban renewal were critical to the eventual packaging of what became the CityCats. The story of how the Brisbane system was developed, what influences were present, the planning process that were involved, and how the idea spread is instructive, and helps explain how and why transport innovations occur.

Introduction

As cities look toward how to best improve their public transport offering, a growing number are investing in urban transit ferries. These ferries run routes parallel to rivers using high speed vessels stopping at destinations along the river (Thompson, 2006) linking up key areas and operating closely with existing public transport modes. This operating model not only adds to the variety and capacity of public transport in the city, but contributes other benefits, such as facilitating economic development and tourism. This paper focuses on one example of these modern ferry transit systems, Brisbane’s CityCats. It will explore the story of its emergence, from how the idea first arose from the previous history of transport on the Brisbane River, through to the progression to the current form of the ferry system and the effect it has had on Brisbane. The paper will also draw on the experience of other compatriot systems around the world and their paths in developing their systems. Innovation theory is used to frame the emerging themes identified in an effort to understand and suggest how experiences in transport innovation occur and the implications this has for transport planning. The CityCats are more than just a plan or policy; they brought a new product to the public transport market in Brisbane. As such, innovation theory is used in conjunction with planning theory to better help explain how this product was developed.

The paper begins by introducing this innovation theory and how it may apply to the introduction of new forms of transport. Second is an overview of the CityCat system in Brisbane and its current scope of operation and context within Brisbane’s transport hierarchy. Following this is a description of the methodology used in the study. Next, the results are presented under themes that reflect the key factors that were identified as most influential in the development of the ferry system. Finally, the implications for transport innovation theory and the future development of urban ferry systems is discussed, with further avenues for research suggested.

Transport innovations

Innovation is generally seen as a process of learning, shaped by particular drivers and mechanisms (Mytelka & Smith, 2002, pp. 1467-1468). There are two competing views as to how this occurs: linear models of innovation, and systems-oriented models. Linear models conceive of research and development as fitting the frameworks of the applied sciences, whereby innovations begin with basic research and eventually transform through to real-world commercial products (Edquist & Hommen, 1999, p. 65). This may have some validity when considering the development of particular transport technologies. For instance, basic science on magnetic levitation led to the development of Maglev propulsion systems and eventually supply of infrastructure and vehicles for facilities such as Nagoya’s Expo Line maglev system. But linear models of innovation fail to recognise the many feedback loops that occur as innovations come to fruition, including in product development and marketing. And they fail to understand the organisational and political factors implicit in transport innovations. Nagoya would
never have invested in maglev were in not for the political demands of officials hosting a World Exposition.

Systems-oriented models of innovation look much more at the demand-side of technology procurement. Actions of the state in procuring public transport involve a multitude of issues and often involve an iterative process of learning about vehicles, signals, track and related infrastructures. Systems-oriented models allow one to look beyond the simple process-based explanations for advances in technology, to explore the relations between actors, between systems, and the roles of rules, regulations, organizational norms and the like (Edquist & Hommen, 1999, pp. 65-66). Systems-oriented models are open to the ideas of planning theory. In this approach, institutions and lead actors, such as key transport bureaucrats or officials, become much more important in providing explanations for innovation. Also opened up are evolutionary explanations for technological innovation. Vincenti’s insights into the role of not just technical problem solving, but also organisational factors, market disciplines and the profitability of firms in the development of retractable landing gear for aircraft is one example of the better explanatory power of such approaches (Nelson, 1995, p. 63). Feitelson and Salomon (2004, pp. 11-12) use a political economy approach to suggest that to be successful transport innovations must have technical feasibility as well as economic, social and political feasibility. And it is the incentives that decision-makers face, and the coalitions behind such innovations that should be explored (Feitelson & Salomon, 2004, p. 11).

Brisbane’s CityCats

Brisbane’s CityCat system did something innovative in creating such a large, linear ferry system using high speed catamarans (shown in Figure 1). However, the innovation was not only due to the technology of the vessels per se. Nor was the innovation solely about using a linear route parallel to the riverbank – this has been done since at least ancient Egypt. The innovations were more in the overall packaging of the system: its design and management but also its conception within broader planning frameworks, and its branding and promotion within the city. Similar systems have since been developed in London, Gothenburg and on the East River, New York.

At the time of the CityCat system’s development Brisbane’s population was 1.3 million (ABS,1993) and the city already possessed a well-developed public transport system incorporating rail and bus services with dense coverage in the inner-city. The introduction of a ferry system added a further travel option within the city’s public transport system. At that time all services, including the new ferries, were not particularly well integrated with one another. With the establishment of Translink in 2003, the network was unified under a zonal based structure with uniform fares across all modes. A smart card system, the Go Card, was introduced in 2008 to allow more efficient fare collection, with 90% of journeys now being Go Card journeys (Translink, 2015).
The system now serves 25 terminals along a 21km stretch of river via a fleet of 21 vessels, with an end-to-end journey taking 76 minutes (Transdev, 2014). Operating hours are from 6am to 12am. A map of the system is shown in Figure 2. There are three different routes: firstly, the CityCat route runs the entire length of the river from the University of Queensland through to Northshore Hamilton using high speed (up to 25 knots) and high capacity (up to 168 passengers) vessels. Secondly, a set of cross-river routes are supplied at low frequencies by the CityFerry mono-hull vessels. Thirdly, a free CityHopper service provides a slower service within the inner-city areas, popular with tourists. The CityFerry and CityHopper both use smaller mono-hull vessels with a capacity of up to 80 and a top speed of only 15 knots (Transdev, 2014). While a relatively minor mode (2% of the total public transport share in Greater Brisbane) the system carries 8.1 million passengers a year and is a significant part of the overall public transport offer, particular servicing key markets such as central business district (CBD) commuters and university students (Soltani et al. forthcoming). It has continually expanded its network with recent new vessels and terminals. But how and why did Brisbane effect this overall innovation? And what can it tell us about how transport system innovations occur?

Methodology
In this investigation the focus was placed on the period from 1990 to 2000 when the initial CityCat system was proposed, designed and implemented. An archival review was conducted of available documents, images and other material from the period. This included concept proposals to council, officially commissioned planning studies and patronage forecasting, as well as impact assessment studies on anticipated effects on the river environment. A selection of six key actors in the planning process was then identified to participate in interviews on their role in the development of the CityCat system. The sampling frame included participants in local and state government, private consultants and also the private contractors responsible for the initial operation of the system. Those interviewed included a former Lord Mayor, a former councilor and head of Brisbane Transport (a Division of the Brisbane City Council bureaucracy), a senior council bureaucrat, a leading transport consultant, and proprietors of two private planning consultancy firms who were engaged to produce planning and feasibility studies for Brisbane City Council. These participants are listed in Table 1. The CityCat system was primarily planned and implemented within local government and the sample is therefore relatively representative. However there is one key limitation. The march of time has meant some key actors have moved on. Despite many attempts no interview was able to be conducted with the operators of a previous, more limited, ferry service on the Brisbane River. As such, the available data is less than desired on the development of the CityCat concept prior to the engagement of council.

![Figure 2: Brisbane’s current ferry network (Source: adapted from Translink, 2014)](image-url)
A semi-structured interview format was used to allow respondents to tell a narrative of their experiences in the first instance, with questions and prompts used to guide discussion and allow for consistency and verification. Interviews were conducted in a combination of in-person and phone interviews. Responses were recorded and partially transcribed reflecting identified themes. Respondents were primarily involved in either the initial stage of idea conception, or responsible for developing the concept through to implementation with interviews structured accordingly. Manual coding was used to identify and theme the data into the categories that follow. Field investigations were undertaken on the CityCat system in 2014 and 2015. Similar interviews and field investigations were undertaken in London, New York, Gothenburg, Stockholm, Hamburg and Bangkok in late 2014. However, we only draw on these materials at key moments, to highlight comparative experiences, concentrating instead on the Brisbane example.

Results
The study found that at every stage of the planning process there were key actors that were critical in the progression of the CityCat concept. The sequence of events is critical to understand and was summed up neatly by one participant as: “the idea, the bureaucrat, (and) the politician” (LC2). Firstly, a pair of entrepreneurs with marine experience formed the initial idea of a linear style catamaran service along the Brisbane River. Secondly, local government bureaucrats harnessed the potential of the idea, giving support and progressing the concept by allocating resources and commissioning planning studies to build a stronger case. Finally, the need to win government-wide support for implementation was achieved though the Lord Mayor who “knew a good idea when he saw one” (LC2, 2015). One thing to note is that many of the participants rushed to claim ownership of the success of the system for themselves. Not always were these claims corroborated by others, but in general all the key actors involved played an important role at some point. Teasing out exactly who made key innovations, at what times, and the level of their creativity, was pointedly difficult. Following is a mostly chronological description of the processes involved, exploring key themes that were observed.

1. The emergence of the idea
Critical to the first seeds of the CityCat concept was the influence of those “on the water” who had the initial idea to update and replace the existing fragmented cross-river and single destination ferry services into an expanded and unified public transport ferry system (Brisbane City Council, 1993). Beginning from the mid 1960’s Brisbane had a privately operated river ferry, the “Golden Swan” ferry service later branded as the “Golden Mile” operating from Hamilton up river on the east side through to a terminal in St Lucia on the west (Brisbane Transport, 1993). A cross river service from the University of Queensland to Dutton Park was also privately operated. Five other cross-river ferries were also in operation across the Brisbane River with a total of 9 separate ferry services operating, as shown in Figure 3. The system was not particularly efficient, with many services operating with high passenger subsidies (Brisbane Transport, 1993).

The Golden Mile service operated up until 1991 when losses forced its closure (LC3, 2015). The proprietors at the time, River Connections, foreseeing an imminent demise under the previous operating model proposed a linear system unifying the existing ferry services, as they saw the potential for growth in passenger patronage and future success if the system was reorganised. “They (River Connections) came to us with the idea and Neil Cagney (then a key Council bureaucrat) and I worked together to build a case for it” (LC2, 2015). The motivations for the operators were relatively clear – innovate or perish. Were existing services profitable the CityCats might never have been conceived. The previous operators developed this notion of cross-river services being subsumed into a linear route that also offered cross-river options. Owing to recent technological advances these were to be serviced by newer low-wake, high speed catamarans.

This conceptual idea received preliminary support from key councillors and a tendering process began for concepts and proposals to operate a new form of service. This first tender was won by River

<table>
<thead>
<tr>
<th>Participant</th>
<th>Role</th>
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<tbody>
<tr>
<td>LC1</td>
<td>Former Lord Mayor of Brisbane</td>
</tr>
<tr>
<td>LC2</td>
<td>Former head of Brisbane Transport</td>
</tr>
<tr>
<td>LC3</td>
<td>Senior Brisbane City Council bureaucrat</td>
</tr>
<tr>
<td>PC1</td>
<td>Public transport consultant</td>
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<tr>
<td>PC2</td>
<td>Transport consultant</td>
</tr>
<tr>
<td>PC3</td>
<td>Private consultant</td>
</tr>
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Table 1: Interview participants
Connections, whose initial ideas were part of what was eventually implemented (and formed part of a later operating contract won by Transdev in 1997, who continue to operate the CityCat service today). The importance of those involved in the day-to-day operations of the previous ferries and their identification of the potential for a restructured system was therefore critical in pulling the first concepts together and placing them within the public arena. Interviewees felt they were onto a good idea: “they were a private company there to make money so...they knew it could work” (LC2) and that they were “best placed to provide that operator knowledge and insight (PC3, 2015).

Figure 3: Ferry services prior to the CityCats (Source: Brisbane Transport, 1993)

2. Sharing a vision and communicating it effectively
The role of key bureaucrats in the CityCat's development was critical from this point. It took “an imaginative and forward thinking bureaucrat in Neil Cagney”(LC2, 2015) who picked up the idea and ran with it. Within Brisbane City Council this support gained momentum and others were won over in what became the emergence of a shared vision. There was a growing belief that, if implemented, linear ferries could work in Brisbane. Support from local councillors and the bureaucracy as a whole followed, due in part to the way in which the project was communicated to others, and allowing those to take ownership. One participant noted “I think (a shared vision) occurs when a project is bigger than yourself” (LC2, 2015). In this way, the Councilor who was Chair of Brisbane Transport and her lead bureaucrat clearly took on the role of policy entrepreneurs (Feitelson & Salomon, 2004, p. 16), shaping and promoting the CityCat concept and developing the idea with expert consultant support (PC1 and PC2, 2015). Through this support the idea gained legitimacy as planning studies and expert reports were produced on topics such as terminal locations and design, vessel design, riverine ecosystem impacts and modelling to predict future demand, all pointing towards feasible options (Brisbane Transport, 1993).

The support of these studies turned out to be critical in fulfilling the next requirement which was the need to promote this vision and co-opt others (Innes and Gruber, 1995). The importance of building a strong case was highlighted as critical as the Lord Mayor was renowned for the "uncanny ability to see flaws in an idea, so preparation was really important" (PC1, 2015). This supports the idea that a political champion is needed in transport infrastructure investments and the important role they play (Tanko and Burke, 2015).
There was much discussion from the participants about the level of creativity that emerged at this part of the process. There was a need to be creative and adaptive given off-the-shelf expertise in what became known as linear ferry operations did not exist in Australia at the time. They were in many ways pioneering a new approach to the problem. As one interviewee noted: “...we didn’t know about these ferry systems, (we) had to use our best knowledge to implement a solution that fit (PC2, 2015).” Another found the task to be positively liberating “it was new territory. We could be iconic and provide world’s best practice” (PC3). These are big claims but there was ambition by the actors involved, and they certainly saw themselves as doing something on the cutting-edge.

One issue that did cause them serious technical and political risk was erosion. The large mono-hulled vessels of the past were causing considerable erosion to the riverbanks and there was understandable concern from residents that this would be increased with faster catamarans (LC2, 2015). However at this point technological advancements were converging that were favourable to the project. So important were the new low wash vehicles coming on line just in time, that “if they (River Connections) had come to us 6 years before with this we’d have to have said no” (LC2, 2015).

The role of technical appraisals prior to any commitment to the ferry system is in contrast to the decisions regarding the development of Brisbane’s busways, which happened at a similar time in the city’s history. In a study on the similar implementation of the Busway system it was found that technical rational analysis was only used to support a decision that was already made (Tanko and Burke, 2015) rather than to help in decision-making as in the ferries. This is partly explained in their being only one level of government involved in the CityCats development, and their being almost entirely a local government decision (they continue to be managed at the local level), whereas the Busways were built and continue to managed by the Queensland State Government (LC3, 2015).

3. To see, experience and support
Progressing the idea from the initial proposal, through to bureaucrat and councillor support, to finally mayoral support involved a translating of the knowledge that the idea would work to those in government to influence their decision. Local councillors were confident in the idea, but providing first-hand experience to the Lord Mayor of similar ferry systems was a key contributor to the final decision. At the time the CityCats had few exemplars to draw on. The Grand Canal in Venice is a very different context with a slower speed. However, there was a service operating on the Parramatta River linking to Sydney’s CBD. A field-trip was arranged, which may have been the key deciding factor to implement the CityCats: the former Lord Mayor recalling he thought: “why don’t we have these things in Brisbane” (LC1, 2015), upon seeing and riding the Parramatta service first hand. This highlights the valuable role that the planning field-trip continues to play in the evolution and development of transport innovations (Tanko and Burke, 2015)

4. Changing mentality, risk taking, and city branding
Risk taking was a necessity for innovation to occur in this case. In order to take this risk though, it was observed that an inner-belief that the city needed to (re)develop allowed for calculated risk taking. In Brisbane this transpired after having experienced change in the identity of the city in the late 1980’s. Interviewees repeatedly mentioned the role of the 1988 World Expo in Brisbane as a watershed moment that changed how the city saw itself forever (LC1 and LC2 2015). It gave the city the confidence that it could compete on the world stage, and significantly, the confidence to be a leader to forge forward with an untested idea. “After Expo there was a change in how people thought about Brisbane” (PC2, 2015). There was a new openness to the river itself and for habitation along it. But the whole ferry system concept was largely untested. Except for the Sydney example there existed little evidence that the vessels could work in the Brisbane context if packaged in the way being conceived. Initially “we didn’t even know what these things looked like” one of the consultants involved offered (PC2, 2015). What helped this risk-taking was a low-cost, small scale roll-out for the preliminary system. Only four vessels were launched initially, offering relatively low frequencies, and only a modest number of cheap terminals were constructed, using spud-barge designs that proved problematic in the 2011 Brisbane floods. The low-costs were counter-weighted by multiple benefits, which was perceived by the interviewees as a contributor to its success (PC2, 2015). The system has continually expanded since, with new vessels, new terminals and terminal upgrades.

In addition, there was a campaign led by the Lord Mayor, to change the conception and branding of Brisbane into a ‘river city’. As the former councillor suggested, “At the time people didn’t even know that we had a river” (LC1, 2015). City branding is today commonplace but at that time it wasn’t as well
formalised. The CityCats fit well with this vision, complementing a suite of river orientation and city modernisation plans. The former Lord Mayor noted he had a vision to rethink the city and “the ferries were one of things in a suite of changes that were aimed at highlighting the resource of the river to the everyday resident” (LC1, 2015). And in many ways “the CityCats became the very public face of this ideology, with their visual presence unsurpassed” (LC2, 2015).

Significantly the CityCats were also seen as part of a wider transport and land use ‘solution’, and not just as a basic transport operation. Their link to land development was understood early on. “Importantly we had a land use planner on board immediately, a service designer immediately and it was part of a transport solution designed not just to be a transport solution but a land use solution as well” (LC3, 2015). It is notable that the CityCats provided the first high-quality public transport services to inner-city sites such as New Farm, which were part of extremely successful urban renewal programs that have further promoted the river lifestyle, and which have since leveraged over US$4 billion in private urban investment (Tsai et al. 2014).

The branding of the vessels themselves and the overall system, as the CityCats, became part of the overall implementation plan and part of the innovation that the system became. With their modern designs and distinct new Brisbane City livery, the vessels helped raise the population’s views of what river travel and indeed public transport could be like. Many interviewees fondly reminisced the first day of operation where the City Cats passed under the Story Bridge, the city’s great historical icon believing that they may just be part of creating something of a new icon. It is notable that other urban river ferry systems that have followed Brisbane’s path have also generally branded their system in similar ways, such as the Thames Clippers in London.

5. Experiences elsewhere

Though we focus this paper on the Brisbane case, investigations recently completed on systems elsewhere in the world (Tanko, forthcoming) showed often similar trajectories in how cities came to adopt linear river ferries. That research used similar interviews with actors in London, Gothenburg, Copenhagen, Hamburg, New York and Bangkok. In London, the critical influence of those directly involved working on the river was central to the coalitions that emerged there to first present and then win over support for the development of the Thames Clippers. In New York it was a similar policy entrepreneur in Mayor Bloomberg who championed the East River Ferry, also in part to stimulate urban renewal and a refocusing on the river. The branding and marketing of the ferries in Copenhagen and Hamburg is also much like that in Brisbane, attempting to become part of city iconography. Though space prevents us providing detail, the Brisbane CityCat product development sequence has many parallels with those of similar systems elsewhere. Certain key ingredients seemed to be important for ferry transport innovation to emerge.

Discussion

The Brisbane experience highlights the validity of using systems-oriented approaches for exploring transport innovations. In the case of the CityCat system a “leap of creativity” (Mascielli, 2000 p 181) was required that deviated from a continuous development path into a discontinuous path (Veryzer, 1999 p306-308). The CityCats were innovative in the use of high-speed vessels for urban public transport, on a linear route, connected to the broader city public transport system, to stimulate urban redevelopment, and to provide iconic tourist experiences. While elements of these had been used previously, the overall packaging of the CityCats was a major break from the past and a leap into the unknown for the city’s transport managers. This was not a logical progression from what existed before.

The disparate contribution of many key actors meant a process of feedback and learning at each stage of the concept’s development, from first concepts, to refinement through technical enquiry, to the point where the system was launched. Perhaps a critical component to the story – and something of an accident – was the lack of an established expert in ferries within the council bureaucracy. This meant an openness to new ideas, the involvement of more actors than just the transport bureaucrats, and it meant a need to design on the fly. The economic situation of the previous operators provided motivations but the council officers and consultants shaped and reshaped the vision of what the CityCats could be through processes of technical enquiry and engagement with stakeholders and decision-makers. The Brisbane case showed the value of including actors such as land use planners within these processes, which helped them obtain more than just a new transport function.
Another key insight deriving from this analysis illustrates that, as is common in many fields, persons on the ‘front line’ who understand potentialities and are well placed to develop and proselytise these ideas can be critical to helping bring on innovations like Brisbane’s CityCats. A large part then of the iterative process involved contribution from those with first-hand experience. Veryzer (1999) suggests innovators may gather this tacit knowledge from most fundamentally “learning by doing”, but also those whose tacit knowledge is “gained through a combination of formal education and work experience in his speciality” (Veryzer, 1999). The two existing ferry system operators of the Golden Mile service responsible for bringing this idea firstly to Brisbane City Council were experienced enough to provide this critical knowledge. “They (River Connection) were what you might call practical people, and that’s what you need to have…” (LC2, 2015).

The Brisbane case also seems to show how grounded local knowledge can be combined with outside perspectives and evolutionary adaptation of systems elsewhere (Nelson, 1995, p. 63). It is possible to see evolution from Sydney’s limited low-frequency Parramatta catamaran service, to Brisbane’s more intensive inner-urban system, to the ambitious systems more recently put in place in the East River, New York and on the Thames. This evolutionary pattern exists across both time and space, and replicates in some small way the evolutionary patterns across the world of the early railways and the early freeway systems (Jones, 1989). And, as noted earlier, the planning fieldtrip and experiencing a similar system remains important in both conveying ideas to and influencing key decision makers effectively.

This study found support for Feitelson & Salomon’s (2004) contention that economic, social and political feasibility are all prerequisites for innovation. The economics of the previous ferry operations were fraught, but one interviewee said it would have been socially unpopular to completely remove them (PC2, 2015). Considered-risk taking emerges in such situations. For the local government there were possible benefits that outweighed the costs, particularly if inner-city renewal took off in Brisbane. The value of the CityCats to this agenda has been given evidentiary support with recent research suggest an 8% increase in property values as one travels to the terminals from 2km away (Tsai et al. 2014). In total it is believed that around $4-5 Billion has been accrued from all of Brisbane’s urban renewal in the inner-city, of which the CityCats were a modest part. Similar effects have been found elsewhere, including in New York around the East River terminals (New York City Economic Development Corporation, 2015). Politically, the CityCats were a neat fit for the agenda of a Lord Mayor, and were likely a popular policy measure – unless that is they proved an expensive flop.

The role of policy entrepreneurs within the bureaucracies appears significant, as in the case of Brisbane’s busways (Tanko and Burke, 2015). Further, the CityCats fit perfectly well within the sanctioned discourse of the Soorley administration, which was attempting to re-imagine Brisbane as a River City, and to look to the river as a leisure and amenity resource. Indeed, the ferries became one of the most visible measures to assist the city in that repurposing. Other Australian cities absent of such narratives about their rivers (the Gold Coast, Perth) have not moved forward with linear ferry proposals. But as our ongoing international research is demonstrating (Tanko, forthcoming) cities who have gone through strong re-imaginings like London and Gothenburg have.

A limitation of the research is that it did not explore innovation that occurred with the ferry system in more recent years. The ferries continue to face challenges, and further innovations were required particularly in terms of terminal design and equipment after the 2011 Brisbane flood events, when many terminals were destroyed. Vessel designs have also changed to increase both total capacity and especially the standing areas outdoors, which are popular with passengers. Changes to stopping patterns and timetables continue. These could be explored further. Future research on transport innovations using combinations of innovation theory and planning theory could also be helpful in exploring the growth of new ride-sharing services in cities where it is being proactively encouraged, the introduction of bike-sharing systems in different urban contexts, and other new transport modes emergent in cities.

Acknowledgments
The authors would like to thank the interview participants personally for their assistance in contributing to this research, as well as acknowledge the assistance of Brisbane City Council. We also thank the two reviewers for their useful comments. Transport research at Griffith University is supported by the Academic Strategic Transport Research Alliance, involving the Queensland Department of Transport and Main Roads and the Motor Accident and Insurance Commission.
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Soltani et al, forthcoming. Travel Patterns of Urban Linear Ferry Passengers: Analysis of Smart Card Fare Data for Brisbane, Australia. *Transportation Research Record*


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3 Transport innovations and their effect on cities: the emergence of urban linear ferries worldwide

Chapter 2 looked at an example of how one system was implemented and the reasons behind such a decision. However, the system and its historical and geographic context are not assumed to be typical of all urban ferry systems worldwide. Chapter 3 therefore selected a subset of compatriot systems from different contexts in North America, Europe and Asia that fit the definition of an urban linear ferry system as defined in the introduction. It provides the first analysis of such water transit systems and explores the reasoning behind these operations as well as providing the first description of standard metrics and mapping for comparative purposes.

The work presented in Chapter 3 was previously published in Transportation Research Procedia, Volume 20 as “Transport innovations and their effect on cities: The emergence of urban linear ferries worldwide” by Tanko, M. & Burke, M.I., 2016.
STATEMENT OF CONTRIBUTION OF CO-AUTHORS TO PUBLISHED PAPER

This chapter includes a co-authored paper. The bibliographic details of the co-authored paper, including all authors, are:


The authors listed below have certified that:

1. They meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
2. they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
3. there are no other authors of the publication according to these criteria;
4. potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
5. they agree to the use of the publication in the student's thesis and its publication on the Griffith University database consistent with any limitations set by publisher requirements.

<table>
<thead>
<tr>
<th>Contributor</th>
<th>Statement of contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michael Tanko</td>
<td>Carried out all archival document analysis and interviews; conducted all interviews in field work in late 2014, with visits to each destination</td>
</tr>
<tr>
<td>5 December 2016</td>
<td></td>
</tr>
<tr>
<td>Matthew Burke</td>
<td>Writing of draft and paper revisions and the final manuscript.</td>
</tr>
</tbody>
</table>

Principal Supervisor Confirmation

I have sighted email or other correspondence from all co-authors confirming their certifying authorship.

Matthew Burke
Research questions addressed in this paper and contributions

Primary question

What were the contributing factors to each system being implemented, what functions do they currently serve and what are the system characteristics and metrics?

Secondary questions

- Why was the system installed?
- What was the historical context?
- What the distances and terminal locations of each service?
- How are services operated and managed?
- What are the patronage levels?

Summary of contributions

This paper provides the first international comparative review of urban linear ferry systems. It explores firstly the reasons for installation, both the primary and secondary reasons, then provides an overview of the metrics for comparison to each other compatriot system including system characteristics and mapping of routes and service structure.
World Conference on Transport Research - WCTR 2016 Shanghai. 10-15 July 2016

Transport innovations and their effect on cities: the emergence of urban linear ferries worldwide

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Abstract

Urban linear ferry systems are becoming an increasingly popular transport option for cities worldwide. These ferries stop at multiple destinations in a linear route configuration using high speed, high capacity vessels operating on a scheduled timetable, whereby adding to, and complementing existing public transport systems. This study seeks to provide the first international comparison of urban linear ferry systems, investigate why and how these systems have been implemented, and to explore how this innovation occurred. A set of predefined criteria was established and seven systems were selected for analysis: Brisbane, New York, London, Gothenburg, Copenhagen, Hamburg and Bangkok. The analysis was conducted in late 2014 and involved: i) a review of archival materials and reports for each location; ii) geographical information systems (GIS) mapping to compare route structures; iii) site visits; and iv) interviews conducted with key actors involved in the planning and operation of each system. A focus of the inquiry was why and how these systems were developed and the source of the innovations in each city. The study found that these ferry systems have been implemented for a number of reasons further to people moving, including economic development, tourism and city branding. The role of both private and government policy entrepreneurs was critical in explaining how the innovation occurred in each city. Ultimately, an understanding of the larger contextual role that ferries would play and the political championing of such systems helps to explain these transport innovations and the emergence of urban linear ferry systems worldwide.

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Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY.

Keywords: Ferry, Water transport; Marine transport Public transport; Urban, Innovation; Economic development, Entrepreneur, City branding
1. Introduction

As congestion in cities worldwide grows public transport expansion is seen as a necessary step to relieve pressure and provide opportunities for future travel demand. Many river and coastal cities are increasingly looking toward urban water transit solutions to facilitate this change. Regular, scheduled ferry services running linear routes stopping at multiple destinations (Thompson et al., 2006) using high speed vessels are becoming a popular configuration. Whilst that creates public transport opportunity in the city, these systems also offer other benefits such as activating waterfront land for urban revitalisation and creating tourism opportunities. Whilst these ferry systems are proliferating slowly there has been no systematic review of current operations worldwide. We do not yet know the reasons for system development. And we are yet to discern best-practice aspects of operation that could aid in the planning and design of new systems elsewhere. The emergence of fast linear ferries also provides an opportune case to explore and refine our understandings as to how innovations occur in transport planning. This paper seeks to help fill these gaps in knowledge. A diverse set of case studies are selected from North America (the East River Ferry in New York), Europe (similar services in London, Gothenburg, Copenhagen and Hamburg), Asia (the Chao Phraya Express in Bangkok) and Australia (Brisbane’s CityCats). The paper uses innovation theory to provide understandings as to how such innovative modes of transport originate and the process of their implementation. The paper’s contributions include the first comparison and benchmarking of these systems internationally, as well as conceptual advances in our understandings of how innovations occur in urban transport policy making.

The paper begins with a brief overview of past research on urban linear ferry systems and the justification for the chosen case studies. The paper then introduces innovation theory and how it may apply to the introduction of new forms of transport. The approach and methods of the study are then outlined. The results are presented, beginning with a comparison of system characteristics and a key summary table, with mapping of routes to allow meaningful comparison. Common themes that were found amongst the different cases are identified. Finally, the implications for transport innovations and how they may occur, as well the future of water transit and avenues for future research, are discussed.

2. Background

2.1. Ferry decline and re-invention

Aside from some unique examples, such as in Venice, linear transport ferries are a relatively new transport option for moving urban populations. Whilst ferry transport has enjoyed a long history of moving passengers across rivers (i.e. in New York across the Hudson River) most urban ferries have provided cross-river services only. With the emergence of bridges and tunnels many cross river ferries disappeared with the mode remaining in only isolated places, if not completely abandoned altogether in most cities (Cudahy, 1990). Locations away from the waterfront became more accessible when technologies such as streetcars and the automobile emerged which saw a retreat from waterfront locations and the growth of suburbia (Warner, 1962; Mees, 2009). However, since around the 1980s there has been a shift in urban structure in many cities. Ports moved downriver. Increased commercial, retail and residential waterfront development took place in inner cities. And there was a resurgence of interest in water borne passenger transport. There are a number of factors aiding this trend.

First was the global decline in port uses, manufacturing and warehousing in inner-city waterfront areas, assisted by the rise of “containerisation” (see Levinson, 2010). Upriver inner city ports were replaced by larger down-river facilities able to accommodate larger ships (Baird, 1996 p146-150). Inland industrial parks with no water access but strong rail and highway links became the norm. These shifts opened up inner-city waterfront lands for rezoning. With nuisance removed and a rise of knowledge economy employment in city centres, new gentrifiers shifted in and took up residence in re-developed waterfront dwellings and precincts. This revitalisation, based on residential and commercial repurposing, has occurred in the US, Europe and elsewhere (Baird, 1996 p150-152; Burayidi, 2001 p179).

Second was the active state promotion of and proactive planning by cities to reshape their image, restructure their environs and embrace the waterfront. Many cities began a conscious program of re-imagining themselves as “river cities”, including London, Gothenburg and Brisbane. Incorporating river ferry services has been a part of this suite of reforms, helping create experience of the river and its advantages, and to stimulate waterfront redevelopment
(Weisbrod and Lawson, 2006). Their role in delivering a tourism experience has also been harnessed by the state as part of local and regional tourism promotion, evidenced in cities like London which has the state desire to have 12 million people traveling on the Thames by 2020 (Transport for London, 2013). This has proven successful with Brisbane’s CityCats ranked the #1 ‘Thing to Do’ in Brisbane on the popular TripAdvisor service in September 2015. Recent evidence of substantial land value increases around urban linear ferry terminals in Brisbane (Tsai et al., 2014) shows the returns cities can obtain using ferries as part of broader river-focused urban renewal strategies.

Thirdly, advances in marine technology saw the rise of higher speed, high capacity, low wake vessels that are suitable for urban transit needs (San Francisco Bay Area Water Transit Authority, 2002; Cambridge Systematics Inc., 2003). Quieter, high volume vessels that throw up minimal wash were a necessary precondition for the recent up-swell in system development.

Finally, urban congestion in and around densifying central business districts has resulted in calls for greater public transport supply, for which ferries on uncongested rivers offer significant advantages. Where existing transit infrastructures reach capacity planners can reach for the ferry option, as seen in New York when crowding on the Port Authority Trans-Hudson (PATH) rail link resulted in subsidised ferry services being implemented instead of increasing rail capacity (Weisbrod and Lawson, 2006, p54).

In combination these factors have led to an increase in residential and commercial land uses in waterfront locations and an interest in how urban ferries can serve these new districts. However, ferries are not only now being introduced as feasibility increases to serve as a viable public transport mode, but also being used speculatively to create new economic development opportunities and spur further development.

2.2. Modern linear ferry systems

Urban linear ferry systems feature a set of similar technologies and operating characteristics. Perhaps the most significant innovation is the application of a linear route configuration where services connect waterfront locations along a river or coast, such that ferries run parallel to the shoreline. Cross river services may still be present, however in many cases they are now used in a supplementary fashion to support one or more longer linear routes and provide transfer options. These linear ferry systems feature an urban scale, frequent regular scheduled services, a public transport focus, and the use of medium to high-speed vessels. Urban linear ferry systems are now operating in almost every continent with new systems being considered in cities such as Abu Dhabi, Washington D.C. and Melbourne, amongst others. The systems are designed to maximise transport, tourism and economic development opportunities through vessel design, route design and terminal location. They differ slightly in terms of vessel type, terminal spacing, terminal design and other factors, but each has emerged as an innovative option within its local context. Users of these systems do make use of the linear nature of the ferries, rather than simply travelling cross-river, as shown in Brisbane where 84% of trips travel up or down-river more than two stops, rather than just across one stop (Soltani et. al., forthcoming) But how and under what circumstances did such systems develop? Why do they differ? And what were the sources and inspirations for these innovations?

2.3. Transport innovation theory

Innovation has been suggested to occur in one of two ways: either as part of a linear or a systems-orientated innovation model. Linear innovation models reflect applied sciences in which development occurs firstly with basic research that develops into real-world commercial products (Edquist and Hommen, 1999 p65). Incremental change in transport technology, such as seen in the long-term development of sophisticated high speed rail systems from earlier primitive forms, provides some support for the linear innovation model in the transport context. However, such a model is widely viewed as over-simplistic, neglecting to take into account the many feedback loops that occur in the demand side of product development. Political and organisation factors and their opportunities and constraints are also not considered in the linear innovation model.

Systems-orientated innovation models take a more realistic view of innovation, considering the many feedback paths present in introducing new technology. They consider the iterative learning process of trial and error, for example in the learning process about vehicles, infrastructure and customised solutions for a particular context. They also allow further examination, taking into consideration the interplay between actors, both government and other
stakeholders involved in the process of innovation and their respective roles (Edquist & Hommen, 1999 p. 65-66). This can greatly inform the explanations for how innovations actually occur.

Feitelson and Salomon (2004) further suggest that for transport innovation to occur, three preconditions reflecting the feasibility of a project need to be met. Firstly techno-economic feasibility, encompassing a need for not only the ability of a proposal to technically work, but also the ability for it to pass a cost-benefit analysis to show it is economically viable (Feitelson and Salomon, 2004). Secondly, social feasibility in that the public is likely to accept the proposed innovation to address the problem it is meant to solve. Thirdly, political feasibility, wherein politicians must consider public perceptions and how other interest groups and lobbies must be appeased. Politicians must balance these influences when considering innovations to gain the support of the public and other stakeholders within government and external agencies.

Innovations are also not always developed in response to need but are often entrepreneurial in nature (Feitelson and Salomon, 2004). Two groups that advance innovations in this way are identified. Firstly, private industry actors who are motivated by profit incentives and, secondly, experts and professionals or “policy entrepreneurs” (Kingdon, 1984) motivated by a cause they strongly believe in. Feitelson and Salomon suggest that it is the incentives these decision-makers face, and the coalitions behind such innovations, that are the factors that need to be explored to explain how innovation occurs. Kingdon also highlights the role of timing and how “policy windows”, which are created as a result of political change, can aid in innovation occurring (Kingdon, 1984).

3. Approach and Methodology

The research approach was to source information on the operations, design and development of a set of representative urban linear ferries from across the globe. Our aims were to identify not just how they were designed and operate, but also how they were developed, and how these experiences compare. To fit the criteria of a linear route for this study services that included five or more terminals on a linear route, offering regular scheduled public transport services within the city, were considered. A selection of seven systems was chosen for investigation, limited by the resources available to the research team. These were the systems in London, Gothenburg, Copenhagen, Hamburg, New York (East River Ferry only), Bangkok and Brisbane. Archival review of available materials from each city was collected online and in person, and reviewed. This included official policy documents, planning reports, and maps and imagery of each system. Systems were mapped for comparison purposes using ArcGIS 10.2. Key actors were identified in each jurisdiction and field studies conducted in late 2014 to conduct interviews and study the systems in person. All played important roles within the development of their respective systems. Interview participants are de-identified with their roles outlined in Table 1. Significantly more interviewees were sourced in Brisbane where, as part of a larger study on urban linear ferries, a richer set of insights was sought for future in-depth inquiry. A semi-structured format was used with interviews partially transcribed. Data analysis was conducted manually both at the time of transcription and after, with data coded and themes identified manually using a deductive approach. A focus of the interview discussions was on the period before the introduction of the ferries, exploring the origins of the innovation, and key events in the planning phase through to implementation. Items considered included what and who was influential, the pathways taken in matters such as route and vessel design, the planning and funding mechanisms, and the level of integration with existing transport networks. These themes and their relative importance form the basis for the results and discussion that follows. The subsequent progress of each system is addressed to a lesser extent and only referenced where relevant.
Table 1: Interview participants

<table>
<thead>
<tr>
<th>Interview participant</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>NY</td>
<td>Senior Manager, New York Economic Development Corporation</td>
</tr>
<tr>
<td>LDN1</td>
<td>Senior Manager, London River Services</td>
</tr>
<tr>
<td>LDN2</td>
<td>Senior Manager, Thames Clippers</td>
</tr>
<tr>
<td>GOT</td>
<td>Senior Manager, Styrsöbolaget, Gothenburg</td>
</tr>
<tr>
<td>CPH</td>
<td>Senior Planner, Movia, Copenhagen</td>
</tr>
<tr>
<td>HAM</td>
<td>Senior Manager, HADAG, Hamburg</td>
</tr>
<tr>
<td>BK</td>
<td>Senior Manager, Chao Phraya Express Boat, Bangkok</td>
</tr>
<tr>
<td>BNE1</td>
<td>Former Politician, Brisbane City Council</td>
</tr>
<tr>
<td>BNE2</td>
<td>Former Politician, Brisbane City Council</td>
</tr>
<tr>
<td>BNE3</td>
<td>Senior Manager, Brisbane City Council</td>
</tr>
<tr>
<td>BNE4</td>
<td>Transport Consultant - Brisbane</td>
</tr>
<tr>
<td>BNE5</td>
<td>Transport Consultant - Brisbane</td>
</tr>
<tr>
<td>BNE6</td>
<td>Transport Consultant - Brisbane</td>
</tr>
</tbody>
</table>

4. Results

4.1. System overview and characteristics

Figure 1 shows the context and typical vessels used in each city. The key characteristics of each urban linear ferry system are provided in Table 2. In reviewing the seven systems, they vary in basic characteristics such as the urban environment in which they operate, and vessel and terminal type. Vessels varied from higher speed catamarans used in London and Brisbane to monohull vessels used in other cities, especially in the Nordic cities where weather conditions such as ice floes demand monohull operation. Vessel capacity ranged from 60 passengers for smaller vessels in Bangkok and Copenhagen up to 298 in Gothenburg (including new boats capable of accommodating 80 bicycles on board). The systems also vary in their scale of operations, both in frequency and number of passengers carried yearly, as well as route design. The system in Bangkok overall carries by far the most passengers in total with over 13 million annually. While some services rely on just one main route (New York and Brisbane) other systems use a network of complementary routes with transfer points to other ferries and to other public transport modes, such as in Hamburg (8 ferry routes) and London (6 ferry routes). Figure 2 shows route coverage in each city, at the same scale, for ease of comparison. Gothenburg runs the shortest route at only six kilometers; Bangkok runs linear ferries along 31 kilometers of the Chao Phraya River.

4.2. The role of urban linear ferry systems

Interviewees clearly suggested the systems differed in their primary purpose, with diverse reasons offered for their introduction. Table 3 shows each service and its identified primary and secondary purposes within the city, as revealed from interview data. This is interesting as during interviews it was evident that these systems, right from the beginning, were in many ways planned by quite different actors and agencies, and were intended to do more than simply move people. Many of the urban linear ferry systems would not have been implemented if they had not actively served these non-transport functions. Common themes included the systems spurring economic development, particularly residential and commercial redevelopment, and in supporting tourism, as well as offering public transport, with one of these purposes tending to dominate the others in each separate city. Indeed some participants mentioned that on a solitary basis alone, for example increasing capacity, a system may never have succeeded: “If you are only looking at passenger numbers, there shouldn’t be any harbour bus” (CPH, 2015). Economic development was most important in New York, Copenhagen and Gothenburg; Transport and commuting functions were most important in Brisbane, Bangkok, London and Hamburg. Tourism was less important in the three European cities of Hamburg, Gothenburg and Copenhagen.
Figure 1: Ferry vessels clockwise from top left: London, New York, Bangkok, Hamburg, Brisbane, Copenhagen and Gothenburg. Source: Tanko, 2015
Table 2: Characteristics of the urban linear ferry systems

<table>
<thead>
<tr>
<th></th>
<th>New York</th>
<th>London</th>
<th>Gothenburg</th>
<th>Copenhagen</th>
<th>Hamburg</th>
<th>Bangkok</th>
<th>Brisbane</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Planning authority</strong></td>
<td>NYCEDC (public)</td>
<td>Thames Clippers (private)</td>
<td>Styrsöbolaget (public) /Västrafik (public)</td>
<td>Movia (public)</td>
<td>Hamburger Verkehrsvbund (public)</td>
<td>Chao Phraya Express Boast Company (private)</td>
<td>Translink (public)</td>
</tr>
<tr>
<td><strong>Operator</strong></td>
<td>NY Waterways (private)</td>
<td>Thames Clippers (private)</td>
<td>Styrsöbolaget (public)</td>
<td>Arriva (private)</td>
<td>HADAG Hamburg (public)</td>
<td>Chao Phraya Express Boast Company (private)</td>
<td>Transdev (private)</td>
</tr>
<tr>
<td><strong>Passengers</strong></td>
<td>1.2 million</td>
<td>3.1 million</td>
<td>800,000</td>
<td>500,000</td>
<td>8 million</td>
<td>13.5 million</td>
<td>6.25 million</td>
</tr>
<tr>
<td><strong>Terminals</strong></td>
<td>8</td>
<td>19</td>
<td>6</td>
<td>10</td>
<td>22</td>
<td>38</td>
<td>24</td>
</tr>
<tr>
<td><strong>Routes</strong></td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total length</strong></td>
<td>11km</td>
<td>28km</td>
<td>6km</td>
<td>7km</td>
<td>24km</td>
<td>31km</td>
<td>21km</td>
</tr>
<tr>
<td><strong>Number of vessels</strong></td>
<td>6 (catamaran)</td>
<td>13 (catamaran)</td>
<td>5 (monohull)</td>
<td>4 (monohull)</td>
<td>24 (monohull)</td>
<td>65 (monohull)</td>
<td>30 (21 catamaran:9 monohull)</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td>149</td>
<td>120-220</td>
<td>298 (160 seated)</td>
<td>64-80</td>
<td>500 (seated)</td>
<td>625 (seated)</td>
<td>500 (seated)</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>12 knots</td>
<td>25-28 knots</td>
<td>13 knots</td>
<td>6knot speed limit in Copenhagen harbour</td>
<td>12 knots</td>
<td>15-20 knots</td>
<td>Catamarans: 149-162</td>
</tr>
<tr>
<td><strong>Headway</strong></td>
<td>20 mins peak</td>
<td>30 mins off peak</td>
<td>10 mins peak between Canary Wharf and London Bridge</td>
<td>30 mins on peak</td>
<td>15 mins peak</td>
<td>5 minutes peak</td>
<td>Catamarans: 25 knots</td>
</tr>
<tr>
<td><strong>Operating Hours</strong></td>
<td>6am-8pm</td>
<td>6am-12am</td>
<td>6am-12am</td>
<td>7am-1pm</td>
<td>5am-12am</td>
<td>6am-8pm</td>
<td>5am-12am (until 1am Friday/Saturday)</td>
</tr>
<tr>
<td><strong>Fare (USD)</strong></td>
<td>$4 one way weekday fixed for entire route $6 weekend $1 bicycle surcharge (paper ticket)</td>
<td>$6.50-12.65 zone dependent (prepaid/paper ticket)</td>
<td>$3.25 fixed single for entire route. Free cross river route. No bicycle surcharge (prepaid/paper ticket)</td>
<td>$3.65 fixed entire route</td>
<td>$1.70-$4.55 $1.40 bicycle surcharge</td>
<td>$0.25-$1.10 Zone based</td>
<td>$3.50-$4.10 zone based (prepaid/paper); Free inner city “City Hopper” service</td>
</tr>
<tr>
<td><strong>Facilities</strong></td>
<td>Rooftop open air seating</td>
<td>Minibar with hot and cold drinks, disability access, baby changing tables, newspapers</td>
<td>Toilets/coffee; on-board bicycle storage; disability access</td>
<td>Full disability access on all vessels and terminals</td>
<td>Rooftop open air tables, disability access</td>
<td>English guide on tourist services; no disability access</td>
<td>Coffee, water, snacks; disability access; limited bicycle storage</td>
</tr>
</tbody>
</table>
Figure 2: Urban linear ferry routes at equal scale (Colors indicate different routes).
4.3 Multiple transport functions of urban linear ferry systems

We turn now to look at the transport functions that underpin these transport innovations. The capacity of urban linear ferry systems to contribute to a city’s public transport offering was the primary reason for most cities implementing an urban ferry system, and acknowledged as important in every other city. But there are differences in those cities where private operators innovated on their own, versus those where government played a stronger role in system introduction.

In Bangkok, where there has been a long history of passenger traffic along the Chao Phraya River. A coherent urban linear ferry system first began operation in 1971 (Chao Phraya Express Boat Company, 2015). It was introduced for transport purposes, harnessing the north-south transport opportunities afforded by the Chao Phraya River (BK, 2015). Unlike in the other cities, this was purely a private sector innovation, in that there was very little government support or centralised planning for the establishment of the service. This has proved problematic over time as the system has developed somewhat separately from other public transport developments in the city. The system has struggled to modernise without subsidy and with heavy government regulation allowing only three ticket price changes in 43 years of operation (BK, 2015). Today it competes with other public transport services, something that the operators wish to reduce in the future, with public transport helping to integrate and feed passengers to the ferries, and vice-versa: “I hope that in the future that we can get feeder services... not to compete with other lines” (BK, 2015). Due to the lack of feeder transit currently, and the hot weather conditions, many passengers use motorcycle taxis to access terminals. But these access trips can cost twice as much as the ferry journey itself. Bangkok is now in the middle of a large rail expansion program at the moment, with plans for seven new rail river crossings. The desire to capitalise on this expansion and allow transfers between modes is a key focus going forward for the future of the Chao Phraya Express. But challenges exist and a coherent dialogue between stakeholders is, as yet, lacking despite calls for integration and even new forms of governance: “in my opinion public transport should be under government (control). They can see out this plan better, like train, ferry and bus and new terminals and can mix them up” (BK, 2015).

In Hamburg there has also been a long history of running services along the harbor with a linear service identifiable as far back as 1888. Government planning and investment has helped modernise the system, which links employment centers on the south bank of the Elbe, including the main container facility and the headquarters of Airbus, as well as a major international shipping hub and cruise ship terminal. Gentrification and urban redevelopment has helped reshape the city, which is presently embarking on one of the largest urban redevelopment plans in Europe around the waterfront. The urban development at HafenCity is the key redevelopment area with a new Opera Hall and commercial center currently being developed as “a blueprint for the development of a European city on the waterfront” (HafenCity Hamburg, 2015). The linear ferry system has been used strategically to link and provide public transport supply to these nodes. The stronger hand of European planning has been important in Hamburg, employing a combined transport & land use strategy with the ferries a key component.

Other cities have used ferries to service public transport ‘deserts’. London’s ferry strategy has more been focused on economic development but there have still been attempts to address locations that lack a viable public transport offer, such as at Masthouse Terrace and Greenland. Transport for London explicitly subsidises the routes servicing these terminals which the private sector would not connect to otherwise. In Gothenburg ferry terminals have also been deliberately established where no bus or light rail service exists. And in New York the ferries provided a key transport system resiliency function. Ferries were particularly important following the service disruptions to other modes caused

<table>
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<th>Primary purpose</th>
<th>New York</th>
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Table 3: Primary and secondary purposes of the urban linear ferry systems, as reported by interviewees
by Hurricane Sandy in 2012, when the East River Ferry services were the first public transport operations available to reach Manhattan. And they are seen as offering that capacity to reach locations affected by disasters in future.

Many respondents suggested urban linear ferries work best when they avoid competition with other modes and instead compliment them in areas where ferries can fill a particular void. But it was noted that where there is competition the ferries often achieve significant patronage: “even when you can do exactly that journey another way, [the ferry] is very popular” (LDN1, 2015). This suggests a greater amenity value attached to linear ferry transport, beyond its utilitarian transport functions.

4.4 Economic development

Economic development, particularly through promoting commercial and residential investment was the primary purpose of the introduction of urban linear ferries in New York and Gothenburg. As such, state development agencies have led the planning and development of the ferry systems in these locations. It was the New York City Economic Development Corporation as lead agency that introduced the East River Ferry. Their ferry’s success in creating 8 per cent value uplifts at locations around terminals justified their investment, and they are now progressing the innovation further to a five borough city-wide commuting system (Bloomberg, 2015). In Gothenburg the city’s main new development area on the northern shore of the harbor is a major terminal in their linear ferry system, with the redevelopment agency responsible for both. In London too, development has been proposed around large scale projects such as Battersea Power Station (LDN1, 2015). Recognising their role in stimulating land value uplift, private land developers have been willing to pay for terminals, as seen in Brisbane, London and New York, with some going as far as offering to subsidise fares for a ferry to service their development.

There are also opportunities for smaller scale economic activities associated with these ferry systems. In Bangkok, terminal redesign is a focus going forward (BK, 2015). Terminals and areas adjacent are currently public spaces where people fish or access the river in other ways. But the operators wish to partly privatise and upgrade them, and provide facilities such as convenience stores and ATMs.

4.5 Tourism, city branding and marketing

Tourism and city branding were also identified as important purposes for linear ferry implementation. In many of the city studied the ferries have become a city icon, whether purposefully or not. Often they have been picked up for city marketing as part of a larger suite of rebranding and repositioning exercises, as part of the shift in how cities both see themselves, and present themselves to the outside world. In Brisbane the CityCats were one of many programs that sought to reorient the city to its river in the 1990s, under the ‘River City’ moniker adopted at the time. The CityCats are featured in city tourism marketing and specific vessels are today covered in livery recognising the city’s many professional sporting franchises. In Copenhagen, the re-imagineering of the city provided by their ferry system is subtly occurring, in part through popular media: “it’s more about an image now I will say…. there’s a TV show filmed along the waterfront and it’s always in the background and it’s something that people can relate to’” (CPH, 2015).

The Waterfront Vision and Enhancement Strategy (WAVES), a rejuvenation program brought in by former mayor Bloomberg and Speaker Quinn in New York, embedded the new ferries in a vision of the waterfront as “open space and recreation, the working waterfront, housing and economic development, natural habitats, climate change adaptation and waterborne transportation” (City of New York, 2011). Similarly, the River Strategy in London also promoted transition of waterfront areas to new uses, with ferries both a symbol and a practical means to move more people on the river (Transport for London, 2013). But reanimation by the populace and visitors for London’s ferries has been difficult at times as the services have been established. They were branded in a version of the iconic London tube logo to raise awareness of the ferry transit option as “many people didn’t even know we have these services” (LDN1, 2015).

4.6 The role of entrepreneurialism

Whilst transport, economic development and tourism help explain why systems were implemented, we turn now to
the questions of how the innovation of urban linear ferry systems arose in each city. Interviewees reported that both private-sector entrepreneurs and policy-entrepreneurs from government were critical in the development of each system. In Brisbane, political leaders and senior managers in local government who had embraced a vision for reshaping the city took a strong role in developing and promoting the CityCat system (BNE1, 2015). In Copenhagen too there was also strong influence from local government to have their harbour bus established in the city. They overcame an initial feasibility study that questioned the value of the proposal on the basis of both need and cost. However, a year later other politicians picked up on the plans recognising broader values in “that it will bring higher quality to the sea and harbour area, and support urban development along the waterfront” (CPH, 2015). In New York the initial ferry system was a project of former mayor Bloomberg who advocated strongly for the service, putting significant political capital into developing what some may see as a niche service. His support has been followed by the current mayor De Blasio, who announced the larger city-wide expansion plans.

Private entrepreneurs have also been involved whether in first implementing a service in their own right, as seen in London, or by influencing the decisions to create a public system, as seen in Brisbane. In both cases a critical factor in system development was the involvement of persons with real-world, on-the-water experience of running ferry systems. These individuals helped both in identifying the potential of innovative ferry services, and in influencing others to the concept. In London, after having been involved with previous failures in operating ferry services, a former wharfman with on-water experience became convinced that linear ferries could work (LDN2, 2015). He proceeded to see the London services introduced in their current operating model. Business insight was used to cater the service to a business clientele who valued the social aspect of the trip and pleasantness of the journey in a part of the London public transport market that isn’t particularly price sensitive. The service also gains other revenue from advertising, currently branded with livery for MBNA, a credit card company. The London operations today receive only modest subsidy and are largely “standing on their own two feet” (LDN1, 2015). The London market segmentation approach is quite different to that of New York and Brisbane which have chosen to position their ferries more as a service for all, with attempts at integrating them into the existing public transport fare structure.

5. Discussion

So what do these examples tell us about how transport innovations such as new systems occur? The narratives provided by the interviewees suggest that as far as what we traditionally understand as transport planning, particularly its more techno-rational dimensions, was not greatly employed in most cases. As such, it is hard to fit the stories of urban linear ferry development within the frameworks of normative (i.e. deliberative or collaborative planning). Further, the development of each ferry involved more than a simple progression of technology building on applied research to inevitable implementation. A systems-orientated model of innovation from product development theory (see Edquist and Hommen, 1999), as described earlier, tends to be a much better framing device to help explain what occurred.

The first thing to note is that the mixed objectives for these schemes and their proponents meant that the selection and development of a fast urban ferry concept in each city was brought about by an interplay between leading politicians and senior managers in government, experienced ferry operators, terminal designers, other transport bureaucrats and economic development agency staff – but less so the public at large. Technical and economic feasibility analysis was subsumed to lesser importance, except for more functional questions about the vessels themselves, with the process of planning also subsumed mainly to questions of route design and terminal location. The key issues in cities other than Bangkok and Hamburg were more about the question of if to introduce linear ferries – and of what form.

Second, these cities (and not others) often developed linear river ferries as they “fit” prevailing discourses in those cities about redevelopment and revitalisation of the riverfront. In London the Thames Clippers fit within the Mayor’s river strategy. In New York they fit neatly within the WAVES program. Support and eventually funding and financing were possible because of these linkages.

Third, the role of entrepreneurs in developing and seeing through these visions is clear. In London a self-proclaimed “wharfman” with local knowledge and first-hand experience of ferry services succeeded where others had previously failed. In Copenhagen a government “policy champion” took a project that by all accounts was dead and revived it. In Brisbane both a private-sector entrepreneur and local government champion promoted the cause and co-opted others. A political champion still seems necessary for urban transport innovations to proceed (Innes
and Gruber, 2001; Tanko and Burke, 2015). Usually once senior politicians were on board, so to speak, concepts were then developed with consultants and negotiated with key stakeholders. Visions were then sold to the public imagination. In each case a champion with vision was able to anticipate and make what Forester (1999, p. 179) called ‘practical, micro-political accomplishments’ winning others over through dialogue, coalition-building and other activities. Further, local government politicians playing the role of policy entrepreneur highlights how urban governance has shifted from managerial practices such as the basic provision of services and facilities to an increased preoccupation with entrepreneurial exploration and investment that can encourage local development and drive employment growth (Harvey, 1989). These innovative ferry investments are a concrete example of this in practice. Finally the range of actors involved in the conceptual development phase helped shape what an urban linear ferry system could and should be in many cases. In Gothenburg and Brisbane, at a time where these fast low-wash ferries became technically viable and commercially feasible the concept was grabbed and adopted by the city-boosters and city-shapers as part of ‘river city’ reimaginings and economic redevelopment activities. The ferries may not have succeeded if solely left to the transport agencies and would likely have looked quite different. In the product development phase there were a much broader set of beliefs about the city, about transport and different powers of other political actors that helped shape and promote the ferry concepts. That said, “Imaginative forward-thinking bureaucrats” (BNE2, 2015) were critical to ferry system development in cities such as Brisbane.

Fourth, branding and marketing professionals were an important element in the success of the newer systems. As shown in Figure 1, vessels can be quite distinct with bespoke design, embracing individuality. With increasing globalization and competition, city branding strategies are becoming more common and transport is playing an increasing role. Ferries are high-profile highly-visible vehicles that lend themselves to this role. The CityCat catamarans that resulted from this process in Brisbane, for example, were somewhat inevitably engineered to provide a public transport experience of on-board comfort, with large external decks for city sight-seeing, staff for high levels of customer service, and branded and marketed in ways that all went well beyond that seen on any other mode in the city. Similarly, in New York and London the branding and marketing of the service, its imagery and iconography as sleek new modern river experiences, were clearly important components very early in product development that helped shape the eventual outcomes. While style hasn’t overtaken substance – yet – a tension has emerged.

Fifth, deliberate strategies to embrace trial and error were included in many cases. The tendency has been for systems to start small to allow evolution to occur and to decrease risk of failure. Proving concept and then improving on it during system expansion has been part of the strategy in New York. Ferry systems have the ability to (relatively) easily add and remove services with minimal capital, potentially shifting routes or selling off fleet, and this aids in reducing the perceived risk and allowing a way forward for an unfamiliar innovation (BNE3, 2015). Urban linear ferries, with only relatively modest terminal costs, just don’t bear the large fixed right-of-way infrastructure costs of other modes, lending themselves to this experimentation.

Sixth, whilst there was technical and operational innovation in the cases of these ferry systems, there wasn’t funding or financial innovation. While there was innovation in technology and route design it’s intriguing that no major financial instruments or alternative funding arrangements were used to fund systems, or provide justification and support. Land value capture was discussed in New York but not implemented. Perhaps the modest cost for these systems has meant no need for financial ingenuity. Fortuitous timing in terms of budget availability was mentioned by interviewees in Brisbane (a budget surplus), New York (available funding by the Federal Transport Authority) and Copenhagen (tax reform change in 1998) creating windows of opportunity and reducing risks in terms of economic feasibility.

Of course, the product of the ferries themselves is changing and maturing over time, taking on new roles in each city. Bangkok has moved from a primary commuting focus towards a tourist role and is now looking at the role of the Chao Phraya Express for economic development. New York is attempting to move to a more mainstream commuting purpose via an expanded city-wide network. In Copenhagen what began as a commuting and economic driver has enticed locals and visitors to visit parts of the city that they would usually not venture to for leisure reasons (CPH, 2015). Urban linear ferry systems seem to lend themselves to this adaptation and evolution.

These research findings have a number of limitations. Though a highly representative grouping was used only a subset of existing urban linear ferry systems were included due to resource limitations. Interviews were limited to mostly one or two interviews in each city. Data availability and access was also constrained in some cases, for example with limited patronage data beyond boardings, variation in data collection methods and availability of other system parameters in each city. There are ample opportunities for further research. Issues that remain unresolved
include competition effects and any ‘premium’ offered by linear ferries versus comparative bus or rail services in cities; issues of best-practice vessel design for these systems; guidance for best-practice terminal spacing and route design; and interactions they have with other uses of rivers, such as human-powered craft (rowing clubs). A particular issue that emerges from the data on property value uplift effects around terminals in Brisbane and New York is to see if and how ferry-oriented development may differ from other forms of transit-oriented development.

Acknowledgements

The authors would like to thank the interview participants personally for their assistance in contributing to this research. We also appreciate the assistance of Brisbane City Council. Transport research at Griffith University is supported by the Academic Strategic Transport Research Alliance, involving the Queensland Department of Transport and Main Roads, the Motor Accident and Insurance Commission, and Queensland Motorways Limited.

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Soltani, A, Tanko, M, Burke, M, Farid, R forthcoming 2015 . Travel Patterns of Urban Linear Ferry Passengers: Analysis of Smart Card Fare Data for Brisbane, Australia. Accepted for publication 2015 in Transportation Research Record Journal of the Transportation Research Board.


4  Travel Patterns of Urban Linear Ferry Passengers: Analysis of Smart Card Fare Data for Brisbane, Australia

Phase 1 of the research, incorporating Chapters 2 and 3, sought to look at why systems were installed and provide a general overview of operating patterns. Phase 2, incorporating Chapters 4 and 5, seeks to build on this basis to provide empirical evidence of how people are actually using such services, based on smart card transaction data analysis. Firstly, Chapter 4 seeks to provide a snapshot of the ways in which ferry services are used in the public transport network in Brisbane, Australia. This is the first published research that has looked specifically at the travel patterns of urban ferry system users and this study provides insights into temporal travel patterns, frequency of use and incorporation of transfer with other modes in Brisbane, where the ferry system is integrated into the general public transport network via the Go Card smartcard system.

The work presented in Chapter 4 was previously published in Transportation Research Record No. 2535 p79-87 as “Travel Patterns of Urban Linear Ferry Passengers: Analysis of Smart Card Fare Data for Brisbane, Australia” by Soltani, A., Tanko, M., Burke, M., Farid, R. 2015. The paper is reproduced with the permission of the Transportation Research Board.
STATEMENT OF CONTRIBUTION OF CO-AUTHORS TO PUBLISHED PAPER

This chapter includes a co-authored paper. The bibliographic details of the co-authored paper, including all authors, are:


The authors listed below have certified that:

1. They meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
2. they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
3. there are no other authors of the publication according to these criteria;
4. potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
5. they agree to the use of the publication in the student's thesis and its publication on the Griffith University database consistent with any limitations set by publisher requirements.

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<tr>
<td>Ali Soltani</td>
<td>Big data analysis, preparation of drafts and graphs and writing of final paper</td>
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<td>Michael Tanko</td>
<td>Preliminary conceptualisation of the approach and method for the research with Assoc. Prof. Burke; working with Dr Ali Soltani on ‘big data’ preparation of the Translink Go Card fare transaction data, including use of ArcGIS 10.2, and SPSS 23; assisting Dr Soltani with preliminary analysis; involvement in write up of text and tables; involvement in review and testing of results with Dr Reza Farid at Assoc. Prof. Burke’s request; significant revision and review of the final paper submission.</td>
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<tr>
<td>Reza Farid</td>
<td>Assisted with managing big dataset and querying database.</td>
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Principal Supervisor Confirmation

I have sighted email or other correspondence from all co-authors confirming their certifying authorship and was also corresponding author on the Journal paper.

Matthew Burke
Research questions addressed in this paper and contributions

Primary question

How is a typical contemporary urban ferry system being used? How do passengers use the Brisbane CityCat network and what type of trip patterns are evident in users?

Secondary questions

- What origins/destinations are most popular?
- How are users accessing terminals?
- Are users transferring between modes?
- What is the difference between on and off-peak travel?

Summary of contributions

This paper provides the first published empirical study of urban ferry system use through analysis of smart card transaction data. It then seeks to build on existing theoretical studies exploring the potential use of water transport in cities.
Travel Patterns of Urban Linear Ferry Passengers

Analysis of Smart Card Fare Data for Brisbane, Queensland, Australia

Ali Soltani, Michael Tanko, Matthew I. Burke, and Reza Farid

Urban linear ferry systems are an emerging form of public transport in cities worldwide. The travel behavior of passengers who used CityCat ferries in Brisbane, Queensland, Australia, was investigated with data from 1,675,821 smart card fare transactions for ferry trips made over a 6-month period. Although services used small vessels and had only one main route, about 2.3% of all paid public transport journeys in Brisbane were made on CityCat and the related cross-river ferries. The ferries were used more for commuting and university trips on weekdays with significant patronage in the morning and afternoon peak periods. Use was consistent on weekend days. Although use was strong, most users were infrequent patrons; this use suggested that leisure travel was a significant component of the system. Key terminals with high use rates included those where transfer to cross-river ferry services was possible. The system offered single-stop cross-river travel at many points. However, only 15.8% of paid trips in March 2013 were made this way; 84.2% of trips continued farther up- or downriver. Integration with other buses and trains was significant; about 15% of all ferry journeys were linked to another mode of public transport. Additional investigation into how users access terminals and interact with other public transport modes is suggested. With expansion planned, the CityCat system could increase its contribution to public transport in Brisbane. Increasing the use frequency of the large pool of infrequent riders could increase patronage of the system.

Smart card fare data is an increasingly valuable resource for analyzing travel behavior patterns on public transport systems. New forms of urban ferries are an emerging transport mode in major cities worldwide. Linear ferry systems, which run parallel to coasts or shorelines, are being installed to increase public transport and alleviate transport problems (1). The aim of this paper is to examine the influential CityCat system in Brisbane, Queensland, Australia, one of the first modern linear ferry systems worldwide, and clarify confusion among transport planners about how people use such systems (e.g., for cross-river or long up- or downriver trips). Smart card fare data are used to provide the first analysis of linear ferries, allowing the examination of passenger travel behavior characteristics, ferry use, and how ferries fit into Brisbane’s public transport system—aspects that have important implications for the planning and operation of similar systems.

The rest of this paper is organized as follows. First, background information about Brisbane and its public transport system are provided to set the context, and then the concepts and characteristics of the CityCat system are introduced. The data analysis and method used are described. Results are presented, and then their implications are discussed. Finally, the key operational findings of the study and avenues for additional inquiry are summarized.

BACKGROUND

Brisbane is Australia’s third most populous city, with a population of slightly more than 2 million (2). Located on the east coast, the city is part of the greater South East Queensland (SEQ) urban conurbation, which includes the Gold Coast to the south and the Sunshine Coast to the north. Brisbane has a well-developed public transport system of rail, bus, and ferry services.

The extensive CityRail network comprises 432.5 km of track (much of it duplicated in key corridors) with 11 lines and 214 (mostly three-car) vehicles in use, although frequencies are modest outside of morning and afternoon peak periods (3). The bus system operates 613 bus routes (4). Along 21 km of the Brisbane River, 19 CityCat and nine monohull ferries service 24 terminals in the urban area. Previously planned and operated by separate authorities, the ferry system now is planned centrally by TransLink, a multimodal government authority established in 2004 to unify the fragmented network and increase coordination between modes (5).

The SEQ region features 15 bus operators overall; however, most buses in the Brisbane City Council (BCC) area are run by Brisbane Transport, a division of the BCC. Buses both compete with and service many ferry terminals. Queensland Rail operates the SEQ rail network that services Brisbane and has stations near some ferry terminals. All of the urban ferries are run by Transdev under contract to BCC.

In the SEQ region, fares are integrated across all public transport modes except taxis. Smart cards (branded as go cards) were introduced to supplement paper fare tickets in 2008 and now are used for more than 90% of fare transactions (6). The term smart card encompasses a range of products that possess computer chips for data storage and processing. Smart card applications for fare payment in public transport have become mainstream worldwide in the past 15 years (7). Some advantages of smart card systems include
providing convenience to commuters, increasing service effectiveness, collecting travel data, managing travel demand, discouraging fare evasion, and decreasing social conflicts (8).

For transport researchers and professionals, the most beneficial aspect of smart card systems is the data they offer. Smart card fare data provides geospatial time-stamped records that usually are superior to most other forms of gathered data (9). Used proactively, such data sets are helpful to transportation planners for daily system operation as well as long-term strategic planning of the city network (7). Smart card fare data have been used to explore complex issues (e.g., trip chaining and origin-destination travel by public transport users and the jobs–housing balance of bus commuters in Beijing) and also are useful for more applied analysis of existing public transport systems (10, 11).

The Brisbane go card system is a regionwide, zone-based scheme in which passengers use one card for buses, trains, and ferries. Four types of go cards are available (adult, child, senior, and concession, with a 50% fare reduction for cards other than adult). Users can purchase go card credit at designated shops, kiosks, machines at stations, or online (with the option to record credit card details for automated refills). Fares are collected automatically according to the distance and zones traveled on the network. One attractive feature of go cards for research purposes is that all passengers must touch on and touch off when beginning and ending a route (i.e., when boarding or alighting a bus or ferry or when entering or leaving a train station), which provides origin and destination data records to each transaction (uncommon in most smart card systems worldwide). All fares are processed offboard.

**URBAN LINEAR FERRY SYSTEMS**

Several urban linear ferry systems are in operation around the world, including in Australia (Brisbane and Sydney), Europe (Copenhagen, Denmark; London; and Gothenburg and Stockholm, Sweden), North America (New York City and San Francisco, California), and Asia (Bangkok, Thailand). These systems share common features of urban scale, linear route, high-speed service, and frequent public service timetabling. Weisbrod and Lawson highlight the potential of such ferry systems to provide urban revitalization and widespread economic benefit as well as alleviate traffic congestion and reduce air pollution (12). These services show potential for promoting smart growth by integrating land use around ferry terminals and can be made more resilient against disasters and used for transportation after emergencies (13, 14). Tsai et al. find significant residential property value increases around ferry terminals in the Brisbane system (15).

Little literature reports the planning, operation, or travel behavior impacts of urban linear ferry systems as yet. A 2013 report by the New York City Economic Development Corporation on the modest East River Ferry operations in New York City reveals a weekday ridership of 3,200 passengers, significant peak values for average monthly boardings during the summer months, property value increases around terminals, and leveraged urban development (16). However, the report does not explore in greater detail individual frequency of ferry use, passenger ferry use over an average day, and trip type (cross river or linear). Confusion remains among planners and operators on such questions, including whether these systems provide primarily cross-river travel cost-efficiently while meeting some linear travel demand or primarily long-distance travel while meeting modest cross-river demand. Much of the media coverage on the Brisbane system, for instance, has been on cross-river functions and reductions in cross-river services as a result of cost-saving measures rather than the system’s provision of linear travel (17).

Brisbane’s CityCat fleet has grown from four vessels when introduced in 1996 to 19 vessels in 2014 (18). The network has expanded in recent years, with new vessels and terminals and additional plans for expansion. Figure 1 is a system map (19). In addition to the CityCat and associated Cross River Ferry that are the focus of this paper, a set of smaller, less-frequent, free CityHopper services were introduced in the central city area of the river to serve only tourists and recreational travelers. No ridership data are available because these services are free and no fares are collected. CityHopper attracts less than one-tenth of CityCat ridership.

Figure 2 is an overview of current system characteristics. The system services much of the Brisbane central business district (CBD), where most government and commercial office employment are located, as well as the two largest university campuses: the University of Queensland (UQ) at Saint Lucia, which is the final upriver terminal, and the Queensland University of Technology (QUT) at Gardens Point, which is adjacent to the city center (20). Key terminals in the network include Riverside, where many city workers alight to access the city’s CBD; Bulimba and Hawthorne, where residents have been using ferry service for more than a century (the heritage-listed Hawthorne terminal dates from the 1920s); Teneriffe (opposite Bulimba), which long has been a major crossing point on the Brisbane River; and the university terminals UQT and UQ. Burke and Brown find the system had significant walk catchments; the median distance walked from home to the ferry terminals in 2003 was 890 m (85th percentile = 1.54 km) (21).

**METHODS**

For this investigation, a 6-month slice of go card transaction data comprising more than 69 million trips recorded between November 2012 and April 2013 was obtained from TransLink (22). In March 2013 alone, approximately 15 million entries were recorded. For each transaction, the following variables are recorded: operator name, date and time of the trip (at origin and destination), status of the transaction (boarding or alighting), ticket number, number of passengers, card ID, service ID, journey ID, trip ID, route ID, route direction, boarding stop ID, alighting stop ID, and run ID.

Data mining—a technique that applies tools from statistics, database management, and computer graphics to extract patterns from large data sets—was used to process and analyze data. Data mining functions can include classification, segmentation, description, and visualization. Data were assigned categories, compared with historical data, and grouped in sets that share similarities (different metrics are available); patterns were extracted from the data; and the available information was provided in a format that is understandable to the user (association rules, trees, and graphical representations are common) (23). Then, data were cleaned to remove undesirable details and errors. Also, nonnecessary attributes were filtered according to predefined queries (e.g., bus- and train-only journeys were filtered from the study data set).

Software products (Microsoft Excel, MATLAB, SPSS, CSVSplitter, and CSVEditor) were used to discover some patterns (e.g., route load profiles) and to compute those fields that were not included in the initial data set (e.g., travel time, origin–destination distance, and transaction time for a vehicle at a stop). For analysis purposes and faster processing, the database was categorized in six monthly parts with CSVSplitter.
### FIGURE 1  CityCat network map (19).

**Year Introduced**: 1996

**Management**: Terminals owned by Brisbane City Council (BCC). Most buses in the area of the CityCat network are operated by a division of BCC; passenger rail services are operated by the Queensland government; ferries are managed under contract by Transdev.

**Total vessels**: 19 CityCats, nine smaller monohull ferries

**Maximum cruising speed**: 25 knots

**CityCat ferry capacity**: 149 or 162 passengers per vehicle

**Total service area**: 21 km of the Brisbane River

**Travel time for one-way CityCat trip along the entire route**: 76 min

**Number of terminals**: 24

**Fare structure**: Integrated ticketing; fares integrated to same zonal structure and price as broader Brisbane (TransLink) public transport fares; one-way cross-river adult fare US$2.96, full-route one-way fare $4.12; no monthly passes; 50% concession fares are available to children, full-time students, pensioners, seniors, and defense force veterans.

### FIGURE 2  Brisbane CityCat characteristics (5, 6, 14).
Several limitations of the go card data restrict its application for travel pattern analysis:

- No demographic or trip purpose data are provided.
- A user’s ultimate destination is not necessarily where he or she touches off.
- A go card may be used illegally by more than one person; except for those who register their personal information, ownership remains completely anonymous.
- Card type (e.g., concession) is not recorded in the transaction data.
- The data set for analysis includes CityCat, Cross River Ferry, and CityFerry fare-based services (Figure 1); trips on the free CityHopper service are not recorded and not included.
- Because only 23 days of data were provided for January 2013, the ferry data set was weighted and expanded to produce a comparable monthly figure. March data were used for more detailed analysis to avoid concerns.

For comparisons of weekday and weekend travel, Wednesday and Saturday were chosen as representative of a typical weekday and weekend day, respectively. For the analysis of origin–destination pairs, transfer patterns, and frequency of use, March 2013 was chosen as representative of typical ferry use to avoid holiday periods in Australia. The spatial variability of ferry use was analyzed by listing all of the CityCat and CityFerry terminals used for boarding or alighting along the Brisbane River. The frequency of use of each stop as an origin or destination was examined for this purpose.

In the following section, the question of how ferries are being used in Brisbane is broken down into a series of secondary questions, the answers to which are presented.

RESULTS

Of the 69 million total trip transactions, on average, around 11.6 million were conducted using all modes of public transport each month. Data from all ferry trips for the period November 2012 through April 2013 were selected and cleaned, removing around 2% more records because of inconsistent, missing, or unusable data records (including trips where a passenger failed to touch off the go card or touched on and off quickly at the same place). This final data set of 1,675,821 trip transactions was used for the following analysis: As an example, ferries represented only 2.3% of all go card transactions for public transport on Wednesday, March 6, 2013.

Monthly and Daily Variation

How were the ferries being used? The number of trips per month is shown in Figure 3a for November 2012 through April 2013. As with the New York system, a slight decline in ferry use is observed from December through February, which may relate more to school and university holidays than weather in Australia (where it is summer) (16). The trip rates also vary a little across weekdays (Figure 3b). No significant discrepancy was found among weekdays in December, January, and February. However, this difference was greater for the three other months, with slightly fewer transactions recorded on Mondays and Fridays than Tuesday through Thursday and more transactions on Saturdays than on Sundays.

Variation by Time of Day

The number of transactions made by time of day varied significantly between weekdays and weekend days. Typical weekday and weekend day use patterns are shown in Figure 4. On weekdays, passenger trip numbers are stronger in the morning and afternoon peak periods than in the off-peak and evening periods, as expected, which suggests that the ferries are being used by city commuters during these periods. On weekends, the pattern is relatively constant from 10 a.m. to 8 p.m., but nowhere near at the rates of use during the weekday peak. Again, use of the ferries is modest in late evening. These same patterns repeated every week (i.e., subsequent Wednesdays and Fridays each produced similar results).
FIGURE 4  Typical travel distributions: (a) weekday (Wednesday, March 6, 2013) and (b) weekend (Saturday, March 9, 2013) (SD = standard deviation) (22).
Temporal Patterns over Months

Next, the differences in the travel time during the day were examined. Figure 5 shows that the trip distribution during peak and non-peak hours is relatively similar over the 6 months. Ferry volume was highest during the afternoon peak, followed by the midday period. The large number of trips during the morning peak was significant. The difference in temporal patterns over the 6-month period is not overly significant, and the reduction in morning peak trips during December and January (presumably caused by workplace and university closures for summer holidays) is the most pronounced change.

Origins and Destinations

The boarding and alighting data for the March 2013 go card transactions during morning peak are shown in Figure 6 for each terminal. Some terminals attract significantly more passengers. The most important terminals for passenger boardings are in suburban areas, particularly downstream of the CBD at Bulimba and Hawthorne. The terminal with the most alighting passengers (more than 26,000) during the morning peak is Riverside, in the heart of the CBD, followed by Teneriffe and UQ (more than 7,000).

Transfers to Bus and Rail

In March 2014, 85.8% of ferry trips were made independent of any other public transport, and 14.2% of public transport journeys that incorporated a ferry trip involved transfer to bus or rail. This proportion of passenger intermodal transfer is larger than in greater Brisbane between the bus and rail networks alone. This behavior was apparent at two key terminals: South Bank, which is located near key bus and rail stations, and Teneriffe, where a high-frequency bus to the CBD departs directly from the ferry terminal.

Linear or Cross-River Trips?

A question remains about whether passengers use the ferry system for simple trips across the river or for longer, linear trips up- or downriver. Given that CityCat was introduced to provide linear trips to work and university up- and downriver, is the system meeting its objectives, or could user demands be better served by new bridges?

To explore this question, ferry go card transactions were disaggregated further to identify those trips made explicitly on the CityCat route, the cross-river itineraries between Norman Park and New Farm Park, between Teneriffe and Bulimba, and between Eagle Street and Thornton Street or Holman Street. Journeys made at key cross-river origin–destination pairs on the CityCat route then were identified to isolate the set of transactions that represent simple, one-stop, cross-river trips from the set of transactions that represent longer linear trips along the CityCat route.

Of all of the 316,236 trip transactions made on the ferry system in March 2013, 49,851 (15.8%) were classified as cross-river trips and 266,385 (84.2%) as linear trips. Furthermore, for linear journeys on the CityCats, average weekday travel time is 16 min and average travel distance is 7.4 km, which is rather long. Even though the system is focused more on long linear trips, some terminals have a stronger cross-river function than others. For instance, for 40.3% of all transactions recorded as boarding at Bulimba during March 2013, passengers used the ferry for a simple cross-river trip to Teneriffe and alighted there. In contrast, only 13.1% of transactions recorded as departing New Farm Park proceeded across the river to Norman Park, 9.9% of trip transactions departing from South Bank 1 and 2 alighted at North Quay 1 and 2, and only 2.9% alighted at QUT Gardens Point.

Frequency of Use

Ferry passengers were categorized according to their frequency of use of the ferry system to identify whether they were frequent users. Most go cards are used for transactions with low travel frequency (only one or two trips) (Figure 7). Even though some passengers
FIGURE 6  Morning peak use, by terminal: (a) boarding data and (b) alighting data [22].
may use more than one go card and most trips are made by frequent travelers, many ferry passengers are occasional users. Therefore, the ferries are used by a much wider cohort of the Brisbane community than previously imagined.

**DISCUSSION OF RESULTS**

For a modest service, the ferries perform well. That more than 60,000 go cards were used on the ferries in March 2013 implies that around 3% of the greater Brisbane population of slightly more than 2 million used the system that month. In this city, total public transport mode share was 9.5% in 2009 (the last year such data were captured), with a large bus and rail system (24). Seasonal variation is exhibited in March, when ferry trip rates are highest, and in January, when rates are lowest, probably because of the long university and workplace holidays during December and January in Australia (rather than the winter effects that underlie similar patterns in New York City during the same period) (16). Daily variation also is apparent, with patronage highest Tuesday through Thursday and the least use on Sundays. Use is notable during morning and afternoon peaks on weekdays, which likely proves challenging for system operators. The steadier boarding and alighting rates during weekend days, particularly between 9 a.m. and 5 p.m., presumably result in smoother operation and ease of scheduling.

The terminals with the highest trip production (generation and attraction) were Bulimba, Hawthorne, Teneriffe, Riverside (in the CBD), and UQ. That the CBD and the city’s largest university anchor so much trip making is not surprising. However, strong ferry boardings during the morning peak in suburban and residential locations such as Bulimba are of more interest. Notably, Tsai et al. identify strong property value increases surrounding the Bulimba, Teneriffe, and Hawthorne terminals and significant development of medium-density apartments and townhouses near these sites (15). What makes such precincts work to produce high numbers of ferry boardings—especially given that these suburbs also are serviced by high-frequency buses to the CBD—warrants additional investigation.

Although not reported here because of space constraints, the go card data show that many Bulimba passengers cross the river to access the CityGlider high-frequency bus at the Teneriffe terminal, others journey downriver and alight at Riverside (the same approxi-

![Number of Go Cards Used vs. Number of Journeys](image)

**FIGURE 7** Frequency of ferry use (22).
valuable. The lack of sociodemographic data also limits interrogation of equity and other variables relative to ferry travel.

CONCLUSIONS

This paper examined the Brisbane linear ferry system and demonstrated how smart card data can be used to profile system use. Even though they may be a minor mode in the overall public transport task, these ferry systems can move significant numbers of passengers in their corridor; attract sizeable long-distance linear patronage; and provide more than the cross-river travel that often is presumed. Furthermore, they can attract a significant proportion of a city’s population, both commuters and tourists. Users clearly are willing to combine urban ferry trips with other public transport modes, including for longer linear ferry trips. This information should help with the planning and design of similar systems, as cities such as Washington, D.C., and Abu Dhabi, United Arab Emirates, consider following Brisbane’s lead.

ACKNOWLEDGMENTS

The authors acknowledge the support of TransLink and other offices of the Department of Transport and Main Roads, Queensland Government. The support of Mark Hickman and Neema Nassir of the University of Queensland is highly appreciated.

REFERENCES


The views expressed in this paper are solely those of the authors and do not represent the views of any institution. The authors take full responsibility for all errors and omissions.

The Standing Committee on Ferry Transportation peer-reviewed this paper.
Chapter 5 expands on the previous quantitative work by asking how we can assess whether there is a ‘premium’ attached to ferry travel and if this premium can be quantified. Do ferry users demonstrate excess travel in an analysis of their travel habits? This is a critical question and addresses the theoretical hypothesis that water transit is inherently different from other transport modes, and that there is a unique value attached to urban ferry systems. It therefore builds on earlier chapters which suggests alternative roles for water transit that are currently not captured in current public transport planning discussions. To achieve this, the same dataset was used in conjunction with a selection of co-located bus and ferry stops offering equivalent origin-destinations pairs. A logistic regression model was used to assess the factors that were significant in people’s transport choice between these modes.

The work presented in Chapter 5 is under review in *Journal of Public Transportation* as “Ferry transit systems provide additional travel benefits and encourage excess travel: Discreet choice modelling of bus and ferry trips in Brisbane, Australia” by Tanko, M., Yen, B., Burke, M. I., 2016.
STATEMENT OF CONTRIBUTION OF CO-AUTHORS TO PUBLISHED PAPER

This chapter includes a co-authored paper. The bibliographic details of the co-authored paper, including all authors, are:


The authors listed below have certified that:

1. They meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
2. they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
3. there are no other authors of the publication according to these criteria;
4. potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
5. they agree to the use of the publication in the student's thesis and its publication on the Griffith University database consistent with any limitations set by publisher requirements.

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<td>Michael Tanko</td>
<td>Undertook all smart data manipulation and analysis based on experience from Chapter 4. Contributed to the drafting process and writing of the final manuscript.</td>
</tr>
<tr>
<td>5 December 2016</td>
<td></td>
</tr>
<tr>
<td>Barbara Yen</td>
<td>Assisted in the choice modelling application and writing of results and discussion sections.</td>
</tr>
<tr>
<td>Matthew Burke</td>
<td>Further assisted in the choice modelling process and writing of draft and paper revisions and the final manuscript.</td>
</tr>
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Principal Supervisor Confirmation

I have sighted email or other correspondence from all co-authors confirming their certifying authorship.

Matthew Burke
Research questions addressed in this paper and contributions

Primary question

Is there a premium value attached to the use of urban ferry services, and do users display excess travel in such journeys? If so how can the ‘premium’ attached to ferry travel be quantified?

Summary of contributions

This paper provides the first published empirical study demonstrating excess travel of urban ferry system users and suggests a premium attached to such water transit in a city transport network.
Ferry transit and excess travel: discreet choice modelling of bus and ferry trips in Brisbane, Australia

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Abstract

Recent investment in urban ferry transport has created interest in what value such systems provide in a public transport network. In some cases, ferry services are in direct competition with other land based transport, and despite often longer travel times passengers still choose water transport. The concept of positive utility of travel has found that in some circumstances increased travel time can increase a user’s utility if some benefit it derived from the travel process itself. This paper identifies a premium attached to urban water transit through an identification of excess travel patterns. A one month sample of smart card transaction data for Brisbane, Australia, was used to compare bus and ferry origin-destination pairs between a selected suburban location and the Central Business District (CBD). Logistic regression of the data found that ferry travel tended towards longer travel times (OR=16.103), suggesting commuters will choose longer ferry trips even when a quicker bus alternative is available. Identification of this excess travel suggests that passengers do derive a positive utility from ferry journeys. The research suggests the further need to incorporate non-traditional measures other than travel time for deciding the value of water transit in investment decision-making.

Keywords: Excess travel, ferry, public transport, mode choice, smart card, Brisbane

Introduction and background

A growing set of urban linear ferry systems is now operating in such cities as Gothenburg, Brisbane, New York, London and Bangkok. These water transit systems are characterised by multiple stops along a linear route up and down-river, offering frequently scheduled passenger services. Most of the research so far on these systems has focused on issues of planning and land use implications (Thompson et al. 2006; Weisbrod & Lawson 2003; Tanko & Burke 2015; Tanko & Burke 2016), property value effects around terminals (Tsai et al. 2014, NYEDC, 2013) and passenger travel behaviours (Soltani et al. 2015; Rahman et al. 2016). Two recent studies have also suggested that ferry transport offers additional amenity value when compared to other modes of public transport (Sternius, 2015; Vattenbussen, 2016). But there is little empirical for this contention. This paper intends to fill this research gap to identify the utility that ferry users obtain from their travel beyond getting from point A to B.

Mokhtarian (2005) has shown how travel is not always a derived demand, suggesting that travel can be desired for its own sake, with the destination often ancillary to the travel itself. Indeed, a growing body of research has challenged the disutility of travel assumption in that travel time is a cost that
should be minimized (Jara-Díaz 2000; Mackie et al. 2003). Suggestions offered as to why people choose to travel may include interacting with and enjoyment of the environment, exercise, relaxation, being with others, physical sensation and speed, which all provide additional personal benefits. Previously in the USA the more “enjoyable” active modes such as walking and cycling and to a slightly lesser extent personal vehicle travel are preferred to public transport as a mode when only considering the journey, irrespective of the destination (Mokhtarian & Salomon 2001).

Perceptions of longer journeys also differ according to trip type - long journeys to work are less liked than long road-trip journeys (Ory & Mokhtarian 2005). However, while there has been research on attitudes toward travel times in general there has been less consideration for the amenity issues of public transport in its various forms and how this impacts on excess travel. But can public transport offer such increased amenity, or at least decrease disutility to commuters? Jain & Lyons (2008) suggest that travel time can be a “gift” beneficial to passengers in some circumstances. Some people may choose voluntarily to commute longer in order to gain such personal benefits. This effect can be split into two streams. The first stream involves amenity benefits which involved a passive psychological enjoyment of the journey. This may come from the “buffer” that travel provides between activities in one’s time-space prism. A commute journey may be a pleasant period of down time between the stresses of work and the stresses of home.

There is evidence that people value such transitions. Redmond and Mokhtarian (2001) found that given the choice of a zero-minute commute people would not take it, instead finding an average optimum commute time of 16 minutes (Redmond & Mokhtarian 2001). Amenity benefits may also come from bring close to nature, scenic values or physical activity during travel. The second stream involves the productive benefits of travel, such as conducting work or participating in social networks, or the benefits to one’s broader productivity that can come from reading, email listening to podcasts or engaging with other Information Communication Technologies (ICT). While this is largely seen as simply “killing time”, Jain & Lyons (2008 p.85) instead suggest this may be the only available time for some people to conduct such activities and that this can affect an individual’s choice of mode. People may accept longer journey times as a result of these factors (see for example Bull, 2000; Salomon and Mokhtarian, 1997; Redmond and Mokhtarian, 2001). In combination the amenity and productivity benefits may mean travels will prefer a slower mode that allows them to ‘linger’ rather than a faster mode (Jain & Lyons 2008 p.83). In theory, the users of water transit may be able to benefit both through the passive enjoyment of waterborne transport and its scenic amenity, and potentially from productivity benefits where passengers are more likely to have a seated journey on a stable vessel that makes few stops along the river, unlike the stop-start and lateral motions of a commuter bus.
The existence of any amenity and productivity benefits matters. Cost Benefit Analysis (CBA) of transport projects has often used a monetised travel cost, with in-vehicle and public transport waiting/transfer time generally assumed to be wasted time. The value of travel time often varies by trip purpose and trip type to estimate the cost of travel, with business travel valued higher than leisure travel. Such estimations have proved influential in weighing the benefits of travel time reductions against the cost of investment. Estimations of mode choice also often use travel costs to assign passengers to a mode. If travellers using water transit have different values for travel time compared to those on buses, incorrect assumptions could be made in both cost-benefit appraisal or in mode choice estimation. In Stockholm estimations for water transit users has been shown to underestimate actual patronage, leading planners to apply a scaled travel time factor of 0.6 minutes for 1 minutes of travel time to correct the model estimation (RTK 2005). However, recent stated preference surveys in Sydney suggest urban ferry users have a higher value of travel time savings than bus users, which, although partly based on income, may suggest ferry users are more time-sensitive than bus users (Wang & Hensher 2016 p.5)

A recent study of water transit operators and developers in seven cities across the globe found that CBA was generally not used to support investment of such systems, partly as schemes often failed to rate well under such frameworks (Tanko & Burke 2016 p.11). Cities in Australia and Scandinavia instead made decisions based on other factors such as an intuitive understanding that systems would work, or by justifying the investment with the benefits of land development opportunities in waterfront areas. Rather than identifying a “boat factor” to correct estimations, identifying the value of amenity and productivity benefits that may be captures by transit users could help produce more rigorous investment decisions.

The present study attempts to identify and quantify the excess travel that a set of travellers obtain from ferries as compared to using available bus alternatives in Brisbane. Previous research has described the city’s water transit system and identified its main passenger movements, using smart card fare transaction data (Soltani et al. 2015). This paper extends our knowledge by exploring competition and excess travel in the Brisbane public transport market, looking at the choices of riders on key commuting routes to and from Brisbane’s central business district (CBD). While previous studies have used focus groups and stated preference methods to discern travel preferences (e.g. Jain & Lyon, 2008), this paper uses revealed preference data drawn from a month of smart card transactions in Brisbane. The paper’s contributions are methodological, in showing how fare transaction records can be used to describe excess travel, and applied, in showing the additional benefits that the Brisbane ferries provide to travellers compared to the bus option, which have significant implications for evaluation and investment decision-making around similar systems.
The Brisbane context

Brisbane is Australia’s third largest city with a population of over 2 million and a well-developed public transport system including rail, bus and ferry services (Department of Infrastructure and Transport 2013). A river city, Brisbane has invested heavily in an urban ferry system that covers 21 kilometres and 24 terminals (Fig 1) with 19 larger catamaran vessels (Fig 2) and 9 smaller monohull vessels (for a detailed review of the ferry system in Brisbane see Soltani et al. 2015. The city has 613 bus routes, many of which feed onto an extensive Bus Rapid Transit (BRT) network, and is at the centre of a large commuter rail network servicing the greater South East Queensland region. The whole public transport system is centrally managed by a multi-modal government authority, Translink, with bus and ferry services contracted out under tender from Brisbane Transport and Trandev, respectively (Translink 2016b). Fares are integrated across all public transport modes such that bus, rail and ferry passengers all pay the same if they travel from point A to point B, regardless of which mode they choose. In 2008 a region wide smart card rollout replaced paper ticketing. Today over 90% of all journeys are now made on the “Go Card” system (Queensland Government 2016). The beneficial aspect of smart cards is the rich data they offer particularly with geo-spatial time-stamped records (Bagchi & White 2005), which the Go Card system incorporates in both boarding and alighting times and locations. The Go Card system works on all modes with passengers pre-purchasing credit at designated shops or transit station fare machines. The system is zone based and fares are calculated on the zones travelled and on time of travel, with a 20% reduction in fares for off-peak travel, defined as between 8.30am-3.30pm and 7pm to 3am the next day, and all weekend and public holidays (Translink 2016a). The mode share for public transport in Brisbane is 8% of which 59% is on bus, 39% on rail and 2% on ferries (Queensland Government 2012, p.121). The state and local government subsidies per rider for bus and ferry passengers are significantly lower than those for rail passengers.

Brisbane’s CityCat ferries tend to offer a less direct route and longer travel times than bus alternatives for most origin-destination pairs in and out of the city centre, due to the city’s extensive bus priority and busway systems, which provide one of the world’s largest dedicated grade- or laterally-separated BRT systems (see Hoffman 2008). However, the ferries also arguably offer better amenity, with more room and seating options, and the environmental qualities of travel on the river. The CityCat’s may run at lower frequency on certain corridors than buses (and longer average wait times) but tend to have stronger on-time running performance due to there being no traffic lights and few other boats on the Brisbane River. They therefore offer an excellent case through which to explore the ‘excess travel’ hypothesis as it relates to urban water transit systems.
Fig 1 Brisbane CityCat urban ferry network. Source: Translink 2016

Fig 2 A CityCat catamaran vessel used in Brisbane. Source: Matthew Burke
Methodology

We chose to compare travel patterns to and from the Central Business District (CBD) where similarly located stops offer a choice of either bus or ferry for a range of origin-destination pairs along the CityCat route. Transport network data including stop number, stop name and GPS position were obtained via Queensland Government open access data on the Translink website. All stops, routes and associated attribute data were imported in ArcGIS 10.2. Four ferry terminals were chosen for further analysis, three in the CBD and a university district (QUT), and one in an inner-city suburb to compare origin and destination commutes to and from this single location (Bretts Wharf, Fig 3). The terminals were chosen deliberately as they offered co-located ferry terminals and bus stops, with direct, single-seat bus and ferry routes that effectively service the same origins and destinations. These locations are also not in competition with rail services and beyond walking distances from origin to destination, allowing a direct two-mode comparison between the ferries and buses. Bus stops around the ferry terminals were isolated from the rest of the stop data and were buffered 440m as per the mean distance people were found to be willing to walk to bus stops in Brisbane (Burke & Brown 2007, p.21) and which was smaller than the walking catchment of the ferries. All bus stops within this range were included for comparison (Fig 3). Distances for each origin and destination pair for each possible OD pairing (28 in total, 18 bus and 10 ferry) were calculated.

Once these parameters were chosen, a one month slice of Go Card transaction data was obtained from Translink comprising a total of 14,517,530 records. We chose March as representative as there are no major holidays in his month in Australia. The following variables are captured in this data set: operator name, date and time of the trip (at both origin and destination), status of the transaction (boarding and alighting), de-identified smart card ID, service ID, journey ID, trip ID, route ID, route direction, boarding stop ID, alighting stop ID and run ID. Data mining methods were used to clean the data and process it into a usable format. SPSS 23 software was used primarily to query and transform the data via the inbuilt syntax editor. Firstly, missing or otherwise unusable records were removed, including trips where passengers failed to tag off their Go Card, or where they tagged on and off at the same location. These records accounted for approximately 5.4% of all data. All rail transaction data was then removed (3,321,690 records) leaving 10,403,880 bus and ferry records remaining. The data was then transformed into the same format of Translink stop data and stops were then matched and filtered to leave only trips between the pre-selected bus and ferry stop origin and destination pairs. After this process 18,569 records were found representing trips between these pairs. All trips in the study are single seat journeys with no transferring included.
Fig 3 Bus and ferry routes from Bretts wharf to Brisbane CBD, showing origin-destination bus stops and ferry terminals
Results

A number of variables were derived from the existing data. Firstly, travel time was calculated from the difference of alighting and boarding time stamps. Distance of journey was derived by measuring the route shapefile length of each origin destination pairing of stops to and from the city. For the selected stops there are two separate bus route numbers (300 and 305) that follow the same route but only differ in the stops that they make. Boardings and alightings also occur at different stops depending on whether they are inbound or outbound trips. The same was done with ferry trips, where three different trip lengths are possible depending on boardings or alightings at North Quay (the longest), QUT (the middle) and Riverside (the shortest trip). Average speed was then calculated by distance divided by travel time. Finally, two dummy variables were created to indicate AM and PM peak trips. It should be noted that travel fare/cost is not a relevant variable in this context, as bus and ferry journeys have equal fares. Tables 1, 2 and 3 shows the descriptive statistics of the variables used in the study, including minimum, maximum, mean, standard deviation, skewness, and kurtosis values for each bus trips, ferry trips and the totals of all separate bus and ferry trips.

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<td>1</td>
<td>0.055</td>
<td>0.034</td>
<td>0.001</td>
<td>-0.698</td>
</tr>
</tbody>
</table>

Table 1 Bus trip statistics

These statistics show an overall picture of the difference in trip characteristics between bus and ferry journeys in Brisbane. Mean travel times and distance for ferries are both approximately double the bus trip time for the origin-destination pairs being studied. Average travel speeds for bus and ferry trips are similar at around 17-18km/h. Frequencies of ferries are slightly lower than bus departures. Of the total 18,569 total journeys, 13,745 were taken by bus (74%) and 4,824 were by ferry (26%). Logistic regression analysis was then used to predict the probability that users would choose ferry trips between the predefined origin-destination pairs, with the mode selection variable coded as 0 for bus and 1 for ferry.
Table 2 Ferry trip statistics

<table>
<thead>
<tr>
<th></th>
<th>Range</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std.</th>
<th>Variance</th>
<th>Skewness</th>
<th>Kurtosis</th>
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<tr>
<td>Time</td>
<td>Minute</td>
<td>59.23</td>
<td>11.28</td>
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<td>35.734</td>
<td>6.869</td>
<td>47.191</td>
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<td>Distance</td>
<td>Kilometre</td>
<td>3.27</td>
<td>9.27</td>
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<td>10.023</td>
<td>1.298</td>
<td>1.685</td>
<td>1.177</td>
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<tr>
<td>Speed</td>
<td>Km/h</td>
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<td>9.84</td>
<td>49.29</td>
<td>17.097</td>
<td>1.952</td>
<td>3.812</td>
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<td>Frequency</td>
<td>Minute</td>
<td>5.1</td>
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<td>6.75</td>
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<td>0</td>
<td>1</td>
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<td>0.355</td>
<td>0.126</td>
<td>1.983</td>
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<tr>
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<td>0</td>
<td>1</td>
<td>0.23</td>
<td>0.422</td>
<td>0.178</td>
<td>1.275</td>
</tr>
</tbody>
</table>

Table 3 Total bus and ferry trips statistics

<table>
<thead>
<tr>
<th></th>
<th>Range</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std.</th>
<th>Variance</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Minute</td>
<td>63.78</td>
<td>6.73</td>
<td>70.52</td>
<td>23.238</td>
<td>8.389</td>
<td>78.137</td>
<td>1.254</td>
</tr>
<tr>
<td>Distance</td>
<td>Kilometer</td>
<td>8.08</td>
<td>4.46</td>
<td>12.54</td>
<td>6.7123</td>
<td>2.092</td>
<td>4.377</td>
<td>1.414</td>
</tr>
<tr>
<td>Speed</td>
<td>Km/h</td>
<td>40.63</td>
<td>8.67</td>
<td>49.29</td>
<td>17.999</td>
<td>3.169</td>
<td>10.047</td>
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</tr>
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<td>0.95</td>
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<td>4.004</td>
<td>3.725</td>
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<td>0.21</td>
<td>0.404</td>
<td>0.163</td>
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<tr>
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<td>0</td>
<td>1</td>
<td>0.23</td>
<td>0.422</td>
<td>0.178</td>
<td>1.275</td>
</tr>
</tbody>
</table>

A discrete choice model is a widely used tool in transport planning and the most appropriate for this purpose as it represents a comparison of the attractiveness of a finite set of alternatives based on the individual seeking to maximise their own utility (Ortuzar & Willumsen 2011, pp.227–228). The utility of each alternative, in this case bus or ferry, is given as:

$$U_i(a) = \alpha_i + \beta_i \cdot T_{ia} + \epsilon_{ia}$$

where $U_i(a)$ is the utility of mode $a$ for passenger $i$. $T_{ia}$ represents the set of trip characteristic variables of mode $a$ chosen by individual $i$. $\alpha$ and $\beta$ are the parameters to be estimated with $\epsilon_{ia}$ the error term representing the random part of the utility. The available predictor variables were travel...
time (mins), distance (km), speed (km/h), frequency (departures per hour) and two dummy variables, AM Peak and PM Peak. Variable selection for the model then followed with the level of significance determined to be p <0.05. Correlation outputs are displayed in Tables 4 and 5. Due to similar average travel speeds, there is a significant correlation between the travel time and distance, and due to the small variance in distance, travel time was the preferred variable used. Time and speed were also correlated and time was used as the preferred variable in model specification. After significant correlations were determined, a forward stepwise method was used for model development, where variables were added and removed in an iterative process based on theoretical understandings of the impacts of the variables on mode choice. AM Peak was included in the final model but PM peak did not improve the predicting capacity of the model and so it was omitted. The final model and development process is shown in Table 6 including Log Likelihood of improvement through different model specifications. A test of the full model versus against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between choice of bus or ferry $\chi^2(4, N = 18,569) = 18969.717$, $p < .001$. Nagelkerke’s R$^2$ of .938 indicated a strong relationship between prediction and grouping. Prediction success overall was 98% (98.9% for bus and 95.5% for ferry).

The Wald criterion demonstrated that Time (p=.000), Frequency (p=.000) and AM Peak (p=.000) were significant contributors to prediction. The positive coefficient for time indicates that passengers that take longer journeys are more likely to be ferry users. Exp(B) values indicate that when travel time is raised by one unit (one minute) the odds ratio is increased by a factor of 2.282 and therefore commuters are more than 2 more times likely to take the choose ferry trips when compared to the bus option, when controlling for other variables. In this case excess travel can be observed and indicates that passengers are willing to spend more time travelling by ferry between the study’s origin-destination pairs. The negative value of frequency indicates that passengers are more likely to use ferries despite lower frequency, indicating that longer terminal waiting times may also not adversely affect the patronage of ferries. Another possible interpretation for the frequency value is that there is greater variation in bus frequencies between peak and off peak periods, where ferry service is more consistent between peak and off peak periods. As such, during periods of slightly increased ferry services there are much more frequent buses, which may explain the finding of more people choosing ferries despite their comparatively lower frequency during this period. Regarding peak travel periods, the results indicate that trips taken during the Peak AM period (7am-9am, Monday to Friday) are also likely to tend toward a choice of ferry.
## Correlations

<table>
<thead>
<tr>
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<th>Frequency</th>
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</thead>
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<td><strong>Time</strong></td>
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<td>.910**</td>
<td>-.554**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.711</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>18569</td>
<td>18569</td>
<td>18569</td>
</tr>
<tr>
<td><strong>Distance</strong></td>
<td>Pearson Correlation</td>
<td>.910**</td>
<td>1</td>
<td>-.196**</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
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<td><strong>Speed</strong></td>
<td>Pearson Correlation</td>
<td>-.554**</td>
<td>-.196**</td>
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<tr>
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<td>Sig. (2-tailed)</td>
<td>.000</td>
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<td></td>
<td>N</td>
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<td>18569</td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
<td>Pearson Correlation</td>
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<td>-.191**</td>
<td>-.434**</td>
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<td></td>
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**. Correlation is significant at the 0.01 level (2-tailed).

### Table 4 Correlation coefficients between variables

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<th>Spearman's rho</th>
<th><strong>Mode</strong></th>
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<th><strong>PM_Peak</strong></th>
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<td><strong>Mode</strong></td>
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<td>-.084**</td>
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<td>.000</td>
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<td>18569</td>
<td>18569</td>
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<tr>
<td><strong>AM_Peak</strong></td>
<td>Correlation Coefficient</td>
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<td>1.000</td>
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<td>Sig. (2-tailed)</td>
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<tr>
<td><strong>PM_Peak</strong></td>
<td>Correlation Coefficient</td>
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<td>-.279**</td>
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<tr>
<td>Sig. (2-tailed)</td>
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<tr>
<td>N</td>
<td>18569</td>
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<td>18569</td>
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</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

### Table 5 Nonparametric correlations

---

---
Table 6 Final model development and specification

Discussion

The results show the presence of excess travel in the choices of Brisbane public transport users when presented with the option of an equivalent bus or ferry service. One of the main tenets of traditional public transport planning is to reduce trip times, assuming that users seek to maximise their utility by choosing to spend less time on public transport; users will act rationally to do so. As such there has been a policy focus on increasing travel speeds, for instance by creating more segregated busway and rail infrastructure, with comparatively little emphasis on improving facilities and services to increase on-board user experience. However, this research shows evidence that some users will not use time as the only variable in considering their transport options and will in fact choose longer journeys when premium services are provided. The results of the Brisbane study suggest positive time use in daily commuting patterns for ferry users. There are two explanations for the phenomena: it may be due to the amenity benefits of passive, psychological enjoyment of being close to nature, with favourable views and being in a comfortable vessel as opposed to a standard bus. It may also be due to the productivity capacity the ferries offer, given the smooth conditions of the Brisbane River where conducting work or leisure activities may be more possible.

In sum, the on-water experience does appear to contribute to a more pleasant journey which travellers are trading off for travel time losses. Some travellers within the overall public transport market may be more likely to trade-off increased travel time for amenity benefits. In a study of how ferries are being used in Brisbane, Soltani et al. (2015) found there was significant travel on weekends and that many users were infrequent public transport users, suggesting a leisure and tourism factor (Soltani et al. 2015, p.79). This suggests that while the CityCat system provides a commuting role, the Brisbane ferry system also serves leisure and tourism where travel occurs more for the experience itself.
The implications for transport planning are numerous. Firstly, it should be acknowledged that people do consider other factors apart from travel time in their public transport journey, suggesting additional welfare benefits to users. Such finding should be of interest to transport planning processes, with such factors being considered in project evaluations and business cases of ferry systems to capture and monetise additional benefits to riders, where appropriate. More consideration should also be given to amenity as well as such traditional variables as on-time performance, reliability and cost. The Brisbane ferry system appears to support the notion that improved on-board experience can also attract people to public transport. Research on efforts to “win” people to public transport by a new emphasis of on-board facilities is becoming more common (Wall & McDonald 2007; Litman 2016). For example, in New York the MTA hopes that on-board Wi-Fi and USB device charging outlets on its new fleet will convince people of the benefits of buses and change negative perceptions (MTA 2016). But buses, with their significant lateral sway and stop/start motions, do not allow many passengers the potential to read on-board due to increased motion sickness, except perhaps on segregated busway operations. Light rail, heavy rail and ferries may have greater success with such strategies.

Limitations and further research

There are number of limitations to the current study. Firstly, the site was selected specifically to compare bus and ferry service. Additional sites that investigate the effect of Brisbane’s rail networks could also be included. We did not explore weekday versus weekend travel in this study. The influence of transfer between modes was also not included. These offer opportunities for refined analysis in future. Future research could use qualitative research approaches to explore why the amenity value of the ferries are higher. This could include rider surveys to obtain personal opinions and assess other factors including personal preferences for travel.

This would help overcome the limitations of smart card data including the lack of socio-economic or trip purpose information. It would also be possible to look at the amenity benefits that exist in other linear urban ferry operations. London’s Thames Clippers offer a quite different service model to the Brisbane CityCats, with a guaranteed airline-style seat and access to food and beverages, but all at a much higher fare than London’s notoriously crowded buses and Underground rail service (see Tanko & Burke 2016). Similarly, in Sydney fares are more expensive on certain ferries than competing modes, while private ferry operator’s fares are considerably higher, but offer faster modern vessels with a range of amenities (bar, Wi-Fi, better seating etc.). On the other hand Bangkok’s Chao Phraya Express offers more rudimentary vessels and service.
Undertaking similar research in such contexts may help disentangle what comprises the amenity benefits of urban ferry systems, how operators and cities can maximise them, and how planners can incorporate them into cost/benefit analysis.

Acknowledgements

The authors wish to thank Mark Hickman and Neema Nassir at the University of Queensland for their support with data management. The support of Translink is also appreciated in making the data available. Transport research at the Cities Research Institute is supported by the Queensland Department of Transport and Main Roads and the Motor Accident and Insurance Commission. Assoc. Prof. Burke was the recipient of an Australia Research Council – Discovery Future Fellowship (FT120100915) funded by the Australian Government. Views expressed are solely those of the authors and do not represent the views of any institution. The authors take full responsibility for all errors and omissions.

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Soltani, A., Tanko, M., Burke, M.I, Farid, R.: Travel Patterns of Urban Linear Ferry Passengers: Analysis of Smart Card Fare Data for Brisbane, Australia. Transportation Research Record (2535) pp.79–87 (2015)


6 Passenger ferry modernisation in an era of mass rapid transit: The uncertain future of the Chao Phraya Express Boat service in Bangkok

While Chapters 2 to 5 sought to provide an insight into the historic development and current operations of urban ferry systems, Chapter 6 looks to the future and asks what is the way forward for these systems, particularly in cities looking to modernise existing ferry services. This research uses a case study of Bangkok, Thailand, and its Chao Phraya Express Boat service. The service is a unique case in that since starting operation as a formal public transport service in 1971, there has been little change in the locally developed vessels and the infrastructure of the service. Bangkok is now beginning a large rail based public transport expansion program with many new lines running parallel to the river, and in many cases in competition with existing urban ferry services. However, as shown in other cities, water transport can be a complimentary mode that can work within a multimodal network. This research looks to assess the role that an urban ferry system will play in Bangkok, a city which historically has not emphasised multimodal transport, instead favouring private operator led competition between modes. This study answers the question: can ferry services provide a competitive option within public transport networks, and what is their role within wider transport development plans? Will the indigenous water transport services along the Chao Phraya River be phased out under a modernisation agenda, or will these services be effectively used to compliment and feed new rail lines? Such issues are addressed in this paper.

STATEMENT OF CONTRIBUTION OF CO-AUTHORS TO PUBLISHED PAPER

This chapter includes a co-authored paper. The bibliographic details of the co-authored paper, including all authors, are:

Tanko, M., Kongphunphin, C., Tonmanee, C., Burke, M. I., Iamtrakul, P., 2016. Passenger ferry modernisation in an era of mass rapid transit: The uncertain future of the Chao Phraya Express Boat service in Bangkok. Submitted on 31 October 2016 to the World Symposium on Transport and Land Use Research 2017, to be held in Brisbane 3-6 July 2017, which also qualifies as submission to a possible special issue of the *Journal of Transport & Land Use*.

The authors listed below have certified that:

1. They meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
2. they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
3. there are no other authors of the publication according to these criteria;
4. potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
5. they agree to the use of the publication in the student's thesis and its publication on the Griffith University database consistent with any limitations set by publisher requirements.

<table>
<thead>
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<th>Contributor</th>
<th>Statement of contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michael Tanko</td>
<td>Conducted analysis of existing archival materials, both those available in English and those translated from Thai. Prepared interview materials, analysed results and prepared drafts and final manuscript.</td>
</tr>
<tr>
<td>5 December 2016</td>
<td></td>
</tr>
<tr>
<td>Chompoonut Kongphunphin</td>
<td>Assisted in archival document analysis and interviews in Thai and helped in analysis and the writing of drafts and final manuscript</td>
</tr>
<tr>
<td>Chatudom Tonmanee</td>
<td>Assisted in archival document analysis and interviews and Thai translations and analysis.</td>
</tr>
<tr>
<td>Matthew Burke</td>
<td>Assisted in the writing of drafts and final manuscript.</td>
</tr>
<tr>
<td>Pawinee Iamtrakul</td>
<td>Assisted in the writing of drafts and final manuscript.</td>
</tr>
</tbody>
</table>

Principal Supervisor Confirmation

I have sighted email or other correspondence from all co-authors confirming their certifying authorship.

Matthew Burke
Research questions addressed in this paper and contributions

Primary question

What is the future of water transit in cities and what role could they play in the modernisation of transport networks?

Secondary questions

- What factors are important in incorporating water transit in cities?
- What are the facilitators/barriers for water transit implementation?

Summary of contributions

This paper provides an understanding of the role of water transit in cities by using a case study of a city undergoing rapid transport modernisation, and asks what role urban ferry systems may play in future development. The paper offers insights which may be valuable to other cities considering such a water transport option.
Passenger ferry modernisation in an era of mass rapid transit: The uncertain future of the Chao Phraya Express Boat service in Bangkok

Abstract

The Chao Phraya Express Boat service in Bangkok faces significant challenges if it is to thrive as part of the city’s transport future. The city is currently undergoing a period of public transport modernisation where new mass rapid transit lines in many cases intersect with, or parallel, river services. With ongoing land based congestion issues, transit operators and academics are suggesting a rethink of the water transport service as part of an expanded multimodal system to unlock much needed interchange opportunities across transport modes. However, whilst other cities such as Brisbane and New York have seen increased investment and benefits in similar linear ferry systems, Bangkok has struggled to incorporate their water transit into wider riverfront and city development plans. The aim of this study is to assess future rail and water transit transport polices in Bangkok in order to understand their respective roles in the future transport network. The findings suggest that the Chao Phraya Express is an underutilised service that suffers from a chronic lack of investment and an outdated reputation which has impeded modernisation efforts. This contrasts sharply with large investment and forthcoming subsidies flowing readily into new metro and monorail services. While there is acknowledgment in principle of the need for interchange provision and plans to achieve such measures, the evidence instead points to a continuation of hard infrastructure dependence at the expense of organisational and structural reform, a continual point of contention in Bangkok’s transport history. Only by a concerted effort to address underlying organisational impediments to multimodal facilitation will boat services and other modes play a role and the real benefits of the investment of rail infrastructure be realised.
1. Introduction and background

Waterways have played a significant foundational role in Bangkok, both along the main Chao Phraya River, but also along the hundreds of canals (khlongs) that interspersed the city. These networks provided service by rafts, boats and boathouses, facilitating travel and trade along the river (Thaitakoo & Mcgrath. 2010). With modernisation and the arrival of motor vehicles, rapid economic growth occurred and the river’s importance declined (Yodsurang & Yasufumi, 2015). Housing and businesses increasingly faced towards newly built roads, leaving the river neglected. Many canals were paved over (Sintusingha, 2010). As a result Bangkok has “for the last fifty years developed in ways that have largely contradicted such a water-based urbanism” (Thaitakoo, 2008, p.30). Yet a low-cost linear ferry system – the Chao Phraya Express – has continued to operate along the river to this day. As cities elsewhere in the world are revitalising their riverfronts many are introducing similar ferry systems to generate ferry-oriented development. Bangkok too wishes to redevelop along the Chao Phraya but as will be shown there are significant tensions involved between existing landowners, different uses, operators, planners and politicians.

Bangkok’s transport mode share for 2013 is shown in Figure 1, which shows that public transport, along with private taxis and van operations, provides for around half of all trips made in the city. Bangkok’s main land-based public transport services include formal metro, light rail, busway and bus services, as well as a large set of informal paratransit providers including mini-van type operations and smaller motor-tricycles known as tuk-tuks. There are three separate rail services and governance arrangements are complex. The BTS Skytrain opened in 1999, operated by the Bangkok Metropolitan Administration (BMA), on a vertically segregated right-of-way, mostly over existing highways.
The Metropolitan Rapid Transit (MRT) underground system is operated by the Mass Rapid Transit Authority of Thailand (MRTA) and opened in 2004. Finally, the Airport Link Rail Line opened in 2010 and is operated by the State Railway of Thailand (SRT).

Passenger boat services in Bangkok come in three main forms: linear river ferries, cross-river ferries and long tailed boats. The main express boats are the Chao Phraya Express Boat services (Figure 2), which cover a long linear route (that is, parallel to the shoreline) from Pakkret and Nonthaburi in the north as far south as Bang Kho Laem. These are operated by a single private operator, the Chao Phraya Express Boat Company. This service provides a modest part of the city's overall public transport services including key cross-river links, student, commuter and tourist services. It serves 13 million locals and tourists per year making it currently the largest urban public transport ferry service by passengers in the world (Tanko & Burke, 2016). Secondly, cross-river services that connect only two terminals are provided at specific points on the river.

Figure 1. Transport mode share in Bangkok
These are operated by numerous private operators, where bridges are not available. Finally, long tailed boats are used as well, mostly in the canals, which with their narrow design and flat bottoms allow navigation at depths as low as one metre (Hossain & Iamtrakul, 2007). The routes of the present rail and Chao Phraya Express services, the focus of this study, are shown in Figure 3. Currently there are two rail crossings of the river, the second of which recently opened in August 2016, for which a new interchange for rail and boat service is currently being built.

Hossain and Iamtrakul (2007) have previously reported on the decline of many ferry services throughout Bangkok due to competing road transportation options.
They observe that the remaining services provide a significant mode for not only those living near the canals but also for those wish to travel faster than land-based public transport on congested north-south routes by taking advantage of the unobstructed right of way (Hossain & Iamtrakul, 2007). The service is cheaper than most buses and has a significant amount of travel on weekends, as well as weekdays, suggesting the ferries are popular for leisure travel, which equates with usage patterns of linear ferries in Western cities (Soltani et al., 2015). A follow up study has since focused on interconnectivity of canal and rail services lines, which found potential for a city-wide networking plan that could significantly boost public transport capacity and efficiency in Bangkok (Thammasat University 2015b). There are also related
plans to modernise the waterfront and introduce public space and pedestrian and cycle access along parts of the river (Namnart 2016). But little has occurred to make such visions a reality. What is going forward at pace is a large scale rail expansion plan, where by 2029 Bangkok is expected to have eight new river crossings and 200 kilometers of new track. Some of these lines parallel the Chao Phraya River, creating challenges for the ferry operators. There are also major concerns for the city’s long tailed boats which have previously prospered as an alternative to the gridlock of the capital’s car-filled streets (see Mateo-Babiano 2015). Technical planning for integration and modernisation of the ferry system has commenced. This includes fare and service integration and physical redevelopment of the waterfront. But there has been little previous research on how developing cities may undertake ferry modernisation, use ferries to stimulate ferry-oriented development, and maximise their efficiency as part of multimodal systems, upon which Bangkok can draw. The present study aims to fill this research gap by looking at water transport and its future within the context of the rapid modernisation of the transport network in Bangkok.

Cities like Brisbane, Gothenburg and New York show that ferries can effectively complement and compete with rail and bus services along such corridors, if well planned, and that they can stimulate significant land value uplift around terminals (Tsai et al., 2015; New York City Economic Development Corporation, 2013). We thus argue that in order to maximise the benefits of the city’s large rail expenditures Bangkok’s transit agencies must rethink the role of supporting modes and further integrate water transport. Our main contributions are in showing how a set of governance problems, ad hoc investment decisions and cultural views of boat transport as a sign of under-development are all impeding progress. We also provide a series of principles for application when facilitating rail and boat interchange connection and
policies that can help maximise these interchange benefits, which may aid cities interested in making use of water transit systems.

The paper is organised as follows: First, a review explores transport system modernisation in developing countries. Second, the research questions and methods are described, drawing on archival materials and interviews. Third, the results are presented. Finally, a discussion draws out the implications for the future of transport in Bangkok and for water transit modernisation in general.

2. Literature review

2.1 Path dependencies in transport in developing countries

Modernisation of transport takes many forms and may incorporate multiple evolutions. But in general it involves a transition from non-motorised to motorised modes and development of higher-quality and higher-capacity transport services and infrastructure. This usually involves a transition from locally produced informal and improvised transport forms into formalised and planned networks (Vasconcellos 2005). This may occur due to the limits of previous transport networks being reached, or due to economic growth and increased wealth. The shift from walking and cycling and informal paratransit to mass motoring, whether directly to cars or more commonly in South East Asia to motorcycles, is an example of one such evolution. But Low and Gleeson (2001) suggest transport modernisation may also be seen as result of a process of ‘ecosocialisation’ where awareness of environmental and social issues leads to a process of incorporation of these values within a politically liberal agenda and different transport policy prescriptions. As developing cities often have less road space than their
Western counterparts, gridlock and chronic air pollution have been an all too familiar phenomenon in mega-cities such as Jakarta, Manila and Bangkok. Programs to clean up these cities and get them moving via high-capacity public transport have been embraced including in Bangkok (Wasunaratassook & Hayashi 2013). But this has begun to be harnessed to neoliberal profit motivations. New rapid transit systems reshape property markets and developers have formed new growth coalitions with politicians to push particular transit investments and enable profitable urban densification and redevelopment. These generate gentrification and can displace the urban poor further to the periphery (see Choi 2016). In addition, many countries’ reservations about funding public transport programs, driven by financial limitations, and their general tendencies towards urban splintering, result in a stern tilt towards privatisation of transport systems (Rimmer 1986; Shatkin 2008). Planning controls and enforcement are weak with governance regimes in Thailand subject to problems of patronage and capture of regulatory processes (Kis-Katos & Schulze, 2013 p.92).

In such cities, the legacy of past development patterns continues to influence not only contemporary transport plans but wider city development efforts. The tendency towards following the path of least resistance and continuing the status quo is strong. Pflieger et al. (2009) propose the concept of path dependencies to give a better understanding of transport development progress in cities. Path dependencies are defined as “historical sequences in which contingent events set into motion institutional patterns or event chains that have deterministic properties” (Mahoney 2000 p508). Pflieger et al. (2009) identify three types of relations between past and current urban policies. Reproduction involves a status quo approach that continues the regular polices of transport infrastructure production. Developing countries often present circumstances that pose difficulties in changing path and tend to instead favour the reproduction of the status quo. Lack of coordination is symptomatic of
many developing counties, where federal, state and local governments do not plan collaboratively but instead are largely led by private interest groups. Such groups are often separate entities displaying a mismatch of priorities and goals (Vasconcellos 2005) leading to inertia and lack of change, typifying a reproduction path dependency. *Innovation* consists of a break from past policies via a recognition of the exhaustion of existing methods and a will to introduce new and improved policies. Such circumstances may be incorporated within an ecosocialisation movement. The well-known case of Curitiba in Brazil showed innovation where new settings for transport policy were implemented under the administration of Jaime Lerner, as opposed to the more reproductive policies that accommodated cars for the middle and elite classes elsewhere in Brazil (Vasconcellos 2005, p.100-101). Finally, *contingency* relies on specific events that change the course rapidly and shifts path dependencies based on the unexpected creation of new technology or a model of operation that changes systems almost instantly (Pflieger et al. 2009, pp.1428–1434). This is seen in the way that ride-sharing applications have transformed the taxi industry in recent years in Asia and the West. Whilst new ferry technologies have emerged, they are not as radically different as those currently in use in Bangkok. Other forms of policy transfer are needed for the ferry system to be modernised.

### 2.2 Policy transfer challenges

Vasconcellos (2005) highlighted two main problems with transport policy transfer to developing countries. The first is a recognition of a lack of technical capacity in most agencies to carry out plans (see also Healey 1998). For example in Bangkok’s failed BRT system, the project involved specific expertise that was lacking in Bangkok and there was insufficient political will and inadequate institutional arrangements to manage the new
contesting of space along the corridor (Wu & Pojani 2016). The second is in the differing cultures and goals of disparate departments responsible for different aspects who pursue their own objectives in silos. Most cities displaying poor transport outcomes in developing countries show problems of government coordination. In a study of the critical elements for a successful transport strategy Birk and Zegras (1993) found that a government institution with power to influence key elements affecting the transport system was critical. Without coordination and strong institutions, transport plans may incorporate sound policy but falter at the implementation stage. However, the creation of a higher level organisation necessitates transfer of power and responsibilities, and such proposals have often been politically unpopular in developing countries such as Brazil and Thailand (Vasconcellos 2005, p.102). Agencies often develop their own megaprojects, rather than seeking radical reorganisation of the existing transport system. Dodson (2009) observes the reach to infrastructure indicates government unwillingness to confront strategic problems. This also avoids politically unpopular measures such as restrictive policies, where developing countries tend to have few disincentives to car use such as taxes, fuel costs or parking costs (Vasconcellos 2005, p.97).

### 2.3 Social issues and income-mobility paradigm

Income disparity impacts on transport policy and provision in developing countries (Vasconcellos 2001; 2005). ‘Mobility gaps’ arise with low income groups facing restrictions in their travel while high income earners enjoy significantly increased mobility. When economic crises emerge the poor are disproportionately affected. In a study of the impact of the 1997 Asian Financial crisis, a significant decrease in transit use and increase in walking was found in Bangkok (Leipziger 2015). This problem is compounded in cities like Bangkok which have become major producers of automobiles, selling to both domestic and especially
to export markets. But the city has invested heavily in rail in recent years and plans much more, much of it targeted at middle-class groups. In effect the heterogeneous population and division in developing countries, from extremely wealthy to extremely poor and everything in between results in a vastly different use of street space and continued conflict when transport modernisation is proposed (Thynell et al. 2010). In a study by Thammasat University of the potential for a hybrid canal-rail system, they found that 94% of existing canal boat users agreed with plans to establish rail canal connections. Motivated mostly by low cost some 69% of respondents preferred to use canal boats if other mode linkages were possible. When considering the option of a hybrid canal option they concluded that the increased safety and modernisation of fleet was the main priority for passengers as well as more infrastructure such as connecting rail and ferry terminals (Thammasat University 2015a). There are therefore opportunities to develop such a system where the current users see the potential to create greater transport accessibility in the future for Bangkok.

2.4 Ferries and modernisation

Traditional ferry services offered mostly a cross river option in cities founded on rivers or bays, but with the construction of bridges and tunnels many services became obsolete and disappeared (Cudahy 1990). There has been a small set of studies looking at the emergence of linear river ferries in cities in recent years (Soltani et al. 2015; Tanko & Burke 2015; Tanko & Burke 2016; Weisbrod & Lawson 2003). There are a number of reasons for this increasing interest. Firstly, the evolution from inner city port manufacturing and shipping functions (Baird 1996; Burayidi 2001) has opened up opportunities for redevelopment of disused land. Secondly, active promotion of the waterfront as a new urban destination, which has seen strong preference for both residential and commercial repurposing (Weisbrod & Lawson
Thirdly, advances in marine technology has allowed for the development of high speed and more agile vessels suitable for public transport use (San Francisco Bay Area Water Transit Authority 2002; Cambridge Systematics 2003). Finally, efforts to ease congestion on roads and rail have led to investigations toward new inner city transit options and the role that urban waterways can play (Thompson et al. 2006; Thammasat University 2015a). The most significant characteristic is the incorporation of a linear route configuration where water services run parallel to water bodies linking up points of interest much like a common transit line (Thompson et al. 2006). They also offer frequently scheduled services and often high capacity vessels able to reduce boarding and alighting times. Such systems are operating in almost every continent with new systems planned in Abu Dhabi and Melbourne, amongst others (Tanko & Burke 2016).

3.0 Methodology

A mixed-methods approach was employed. Archival review of available transport plans covering rail, ferries and waterfront development was collected in print form, online and in person, then reviewed. This included official policy documents, planning reports, maps and imagery of each network. Where English language versions were not available, translations of reports from Thai to English were completed and then analysed. Field visits as well as regular usage of the boat and rail network were conducted over the period of 8 months from February 2016 to October 2016. Systems were mapped for comparison purposes using ArcGIS 10.2 to visualise current and future intersections of rail and boat networks and identify new connection opportunities. Key actors responsible for planning networks were identified who played important roles within the development of the rail and Chao Phraya Boat network planning. Interviews were conducted face-to-face and participants are de-
identified with their roles outlined in Table 1. These included representatives from the key agencies involved: the Chao Phraya Express Boat Company (the key boat operator), the Mass Rapid Transit Authority of Thailand (the key train operator) and Bangkok Metropolitan Authority’s Marine Department and Office of Traffic and Transport Policy and Planning (OTP). A semi-structured format was used with interviews conducted in Thai and translated into English for analysis. Data was coded and themes identified manually using a deductive approach. A focus of the interviews was the value of the ferries and planning for transport and land use in the city. Questions focused on issues of governance and decision-making, prioritisation, funding, and policies to facilitate multi-modal connection. Items considered included who and what was influential, the pathways taken in matters such as route and vessel design, the planning and funding mechanisms and how these factors have played out historically and what these plans tell us about the future network in Bangkok. These themes and their relative importance form the basis for the results and discussion that follows.

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chao Phraya Express Boat (CPEB)</td>
<td>Managing Director</td>
</tr>
<tr>
<td>BMA Marine Department</td>
<td>Deputy Director-General</td>
</tr>
<tr>
<td>Mass Rapid Transit Authority (MRTA)</td>
<td>Senior Transit Policy Manager</td>
</tr>
<tr>
<td>BMA Office of Traffic and Transport Policy and planning (OTP)</td>
<td>Senior Policy and Planning Analyst</td>
</tr>
<tr>
<td>Thai Boat Association</td>
<td>Managing Director</td>
</tr>
</tbody>
</table>

Table 1. Interview participants
Note that canal boat services were excluded from in-depth analysis in this study but are the subject of separate research by Thammasat University (2015b). The present study investigates the integration of the three current rail lines operating in Bangkok, the BTS Skytrain (1999) MRT metro (2004) and the Airport Link Express Service (2010) with water connections, and therefore focused on the period from 1990 to the present while these systems were being developed.

4.0 Results

4.1 Overview

The first plans to build a major passenger rail network in Bangkok were contained in the 7th National Plan in 1990, whose cornerstone policy was the construction of two mass transit lines. The first train line was the Hopewell project, a failed public-private partnership that was abandoned after only 10% had been completed. The BTS Skytrain was completed in 1999 to somewhat underwhelming ridership. One of the reasons was that there was no complimenting land use plans or modification of other transport modes to service the new rail line. Upon observing the building of the first BTS rail line in Bangkok, it was as if it had been ‘helicoptered in and dropped from the sky’ (Allport et al. 2008, p.40), while everything else stayed the same. The result is a sub-par system that has a limited catchment area to those around the stations due to its lack of planning with other modes. Despite those beginnings, development is now strong around rail stations. New trends of residential development indicate clustering around train lines, where 80 percent of new condominium development in the period July–November 2010 was located along either the BTS, Metro or Airport Link lines (REIC 2010), a trend that has continued to the present day.
The latest *Mass Rapid Transit Master Plan 2010* prepared by the Office of Traffic and Transport Policy and planning (OTP) has set out a much more interconnected vision for the future transport network in Bangkok. Looking at the connection options for rail and boat services the report highlights the increasing need for feeder services. The vision by 2013 for rapid transit, as shown in Figure 4, if for a set of interconnected lines. This map includes existing and future Rail, Chao Phraya Boat Services and the one existing BRT line (regular bus services and canal boats are not included). Intersections of new rail river crossings are planned with new piers to connect with boat services at these points (Figure 5). The plan encourages the “construction of the intermodal transfer facilities (ITF) at each terminal and significant stations, including the public transport interchange (PTI) with feeder bus system, park & ride buildings which can accommodate about 500 vehicles” (OTP 2010). A new design standard for boat and rail terminals at these stations indicates the multimodal facilitation is a key consideration in future plans (Figure 6). This raises the notion of a universal design concept and a move toward uniform terminal design of interchange facilities in Bangkok (Prasertsubpakij & Nitivattananon 2012) a characteristic that other urban ferry systems have used to their advantage in branding opportunities such as in Brisbane (Tanko & Burke 2015).

The MRTA also acknowledges the importance of integration, stating that this convenience is a key driver to attracting people to using public transport in Bangkok (MTRA, 2016). The next two rail/ferry interchanges at Bangpo and Pra Nang Klao, being developed in coordination with OTP, are currently in the planning phase.
Figure 4. Future transport network in Bangkok with new connection boat piers shown.

Source: MRTA 2013
Figure 5. Existing and future rail and boat interchanges in the study area
The OTP believes that even with an expansion of rail, and beyond its feeder role, water services will still have a place as they offer a unique experience away from traffic that many people rely on and prefer to congested land based modes (OTP, 2016). Even the MRTA who are focused on rail provision see the future relevance of water transport in Bangkok:

“The physical layout of Bangkok is centred around the river. Despite there being many new transport options, boats will always remain an important part of transport in Bangkok” (MRTA, 2016)

A multimodal transport card is also currently under development (Mangroom, or spider in Thai) that will allow easier transfer between modes, but initially it will only link the three separate train services (CBEB, 2016). Currently 17 piers are also undergoing minor upgrades to improve safety and install automatic fare collection at piers (BMA Marine Department, 2016). On paper, this planning for ferry modernisation, within the broader network vision, appears very sound.
4.2 Organisational structures

While there exist good plans, many barriers were noted to us by informants. The first was the convoluted set of institutions involved. There is a key split between two ministries, the Interior Ministry and Ministry of Transport. While the OTP is responsible for policy formulation of all modes, it acts mainly in an advisory role, not as a final implementer. Bureaucratic problems have impeded planning efforts by the OTP already, and as a result the organisation is struggling to realise implementation of its plans. The need for a coordinating authority was recognised as early as 1991 in the short lived Bangkok Transportation Planning Unit (BTPU) to aid in communication and planning transport networks (Rujopakarn 1991). But coordination is also needed with urban planning. Visions for a more polycentric Bangkok, first introduced in the Town Planning Act 1975, have not been supported by transport investment (Rujopakarn 2006). Parochial bureaucratic behaviour is not helping commuting patterns that still tend to favour concentration on the congested city centre (Choiejit & Teungfung 2004; Sirikijpanichkul & Winyoopadit 2015).

A promising sign to address this issue is the proposed formation of a new authority, the Mass Rapid Transit Commission (MRTC) that will be charged with overseeing the planning and implementation of the new mass rapid transit network. This is a positive step and an acknowledgment of the critical role a multimodal transport planning authority is in modernisation efforts. However, as yet little is known about the remit of this authority and its responsibilities. What is known is that this new authority will be a modification of the existing MRTA. As the OTP plan describes:
The roles of Mass Rapid Transit Authority of Thailand (MRTA) will be changed. The planning unit will be changed its role to be a MRTC office and the operation unit will be responsible for developing and managing the MRT system. (OTP, 2016)

Whether this will skew the transport focus in favour of rail in currently unknown. Perhaps a telling precedent is that the existing Bangkok Mass Transit Authority (BMTA) oversees buses and highways and this budget is split between these purposes, with the vast majority going to highways. Whether this new authority will remain impartial will be critical in its goal to carry out the planned intermodal connectivity strategy. Another impediment is that rail operators have little incentive to provide connections to other modes as this is not a requirement for receiving their subsidy. In Bangkok it was observed that in many ways the reliance on technology is reflective in the overwhelming majority of construction and engineering emphasis in the public sector and lack of transport planning and policy expertise (Chang-Hee & Suthiranart 2003). Such inexperience in transport organisation reform will likely pose further difficulties in achieving these multimodal connectivity goals.

4.2 Ferry modernisation plans

Interviewees indicated that the water transport system is seen as having a role in Bangkok’s future, despite the ferries being viewed as a minor mode, particularly when compared with the emphasis on rail. This is despite the fact that the Chao Phraya Express carries 13 million passengers a year (Tanko & Burke 2016). Imported technological solutions of heavy and light rail are instead seen as the future of shaping Bangkok. There is also still a perception that boat travel in Bangkok is dangerous and subject to pollution. The aging nature of the vessels
lends a perception of underdevelopment to the network. Changing such opinions can only occur with further investment. However, like the bus system in Bangkok, the historic practice of regulation and lack of subsidy for fares has proven counterproductive as it has not allowed the provision of better vehicles and service, with the company not given the opportunity to prove itself able to provide better services for higher fares. This is not a new phenomenon in Bangkok (see Sricharatchanya 1982; 1983). There was also suggestion that due to the stable nature of water transport patronage, this has led to little incentive for the government to invest, instead perhaps taking the success of the boat services for granted:

Government does not support the boat services as much as rail because boat services have an ongoing stable user base (CPEB, 2016)

However, the recent approval of a 1 baht increase in boat fares is a small, but significant vote of confidence from the government, who have not previously allowed a significant increase in boat fares for the last 30 years (CPEB, 2016; Mahitthirook 2016). This can perhaps now allow the private operator, which otherwise receives no government support, to start to improve and modernise their services. The cost of transport services is also a consideration in Bangkok. For example, it was observed that rail options “cannot be the best choice for transportation in Bangkok because of their fare, and so boats or other public transit modes (i.e. bus and paratransit) are usually the mode of choices for most people” (MTRA, 2016).

The upgrading of 17 existing piers to modernise and improve safety is also seen as going some way to alleviating concerns over safety of boarding and alighting and reducing this barrier to ferry use. Less is happening to address pollution, where average black carbon concentrations around vessels can be much higher than at vehicular traffic sites, and noise
levels are also much higher inside boats (Velasco et al. 2013). However, a recent trial of new solar powered boats in the canal network is currently underway and improvements to the vessels and engines are possible. As found previously in a study of transport mode perception, image is mediated by previous experience; if a positive transport experience is attributed previously to an alternative this negative image is decreased in people’s mind (Hensher & Mulley 2014; Hensher et al. 2015). Like the improved piers, the use of modern vessels may be able to change the perception of water transport in Bangkok.

In addition, Bangkok’s riverfront development agenda is leading a real estate boom. Informants recognised the potential for water transit to position itself within these plans and facilitate economic development and urban renewal. Evidence of this was suggested in the planning of a new riverfront megaproject Icon Siam, the largest land development project ever attempted in Thailand. Yet despite the accommodation for four new ferry piers on the site (two designated for private leisure craft) the planners of the project instead decided to self-fund an ad hoc light rail extension connecting to the nearest train line. This favouritism for rail and lack of confidence in boat services reflects the muted role of water transport in Bangkok. Existing land owners have not generally been helpful in terminal upgrades and interchange development. More than one interviewee expressed the constraint of land ownership, admitting that even the best laid plans are often at the mercy of land acquisition efforts. Processes stretching five years are not uncommon in Bangkok and have already presented connections issues between rail lines alone. This is evidenced by the recent mismatch in the new purple and blue MRT lines, where timeframes for completion did not line up leaving an embarrassing one station 2 kilometre gap in the network that currently requires temporary buses to provide connection while the rail connection is built.
For the ferries there have been problems too, with informants citing the example of the failure to open the purple line’s new boat pier interchange at the time of the rail line opening (OTP, 2016).

The Chao Phraya Express has not been directly supported by land planning agencies or land developers, in the way that similar systems have been in London, Gothenburg or Brisbane to stimulate ferry-oriented development. There is limited understanding of how a modernised ferry system might accelerate land development along the river. Retaining and improving ferry service could help both increase accessibility for the poor who live in the more peripheral suburbs and in the informal settlements along the canals, and who regularly use the system already, but also higher income groups:

*While the poor face a clear limitation in their mobility—the social and economic barrier—the middle classes face a physical barrier caused by increasing congestion. The elite and the middle classes remain prisoners to their concept of life—clearly expressed in the growth of isolated, high-quality residential clusters.* (Vasconcellos 2005, p.103).

Currently though the existing ferry network is not conceived as a mode that wealthier condominium purchasers might use. They are not a ‘transport of delight’ (Richmond, 2005). The Chao Phraya Boat Company is aware of this link between socio economic status and transport mode, which is especially pronounced in Bangkok, with the large difference between the levels of services afforded by different modes:
The main factor in choosing transport types depends on the user. The focus on transportation development is the secondary reason” (CPEB, 2016)

The boat operator doesn’t necessarily see new rail lines as a threat their business where they “believe in the supporting of many modes because of the diversity of the types of people” and the “importance of connections between boat piers and rail stations that may increase the convenience of people in changing mode and further help the areas around new multimodal stations develop” (CPEB, 2016). Furthermore, when questioned about the influence of new waterfront developments such as Icon Siam, they believe that the rail services will cater more toward tourists and this will not affect the boat services who cater predominantly for long travel commuters (CPEB, 2016). This may be interpreted as being resigned to the fact that transport users are committed to their mode based on their status and that not much can change this. There is evidence that habits of public transport users are difficult to change once well established. This may be particular influential in Bangkok where the financial means and living locations of residents is much more a limiting factor in choice of modes than other cities where personal choice is more at play. It also suggests perhaps that the opportunity to take advantage of the renewed waterfront focus to reinvent boat services has not currently been explicitly identified. In discussion with the boat operators, though, it is evident that there is an implicit focus on changing perceptions to increase boat ridership:

“Upgrading the inside and outside of piers with safety upgrades, developing waiting areas, improving the atmosphere and context may help to change perceptions about ferries and get people to consider them an option for middle and upper class commuters” (CPEB, 2016).
However, in order to attract this new more discerning user base would suggest the focus on transport infrastructure and service may need to come first and not be just a secondary concern, as is currently suggested to be the case.

5.0 Discussion

At present Bangkok seems stuck in a reproductive path dependence with the focus on other transport modes. It is not certain how the future of the Chao Phraya Express Boats can be included in future discussions for preservation or modernisation of the service. There is a significant threat to water transport’s viability in the coming decade if there is not a major reconceptualisation of the mode and its potential. Bangkok is making great strides with public transport investment but may be missing an opportunity to create a more efficient and environmentally appropriate ferry operation for more effective transport links and also to perhaps help stimulate economic activity. The roadblocks seem relatively obvious and inter-linked. Without subsidy or an ability to raise fares (and still retain passengers at those higher rates) investment in vessels and terminals will remain limited. Without better vessels pollution problems and safety will deter higher-income riders. Without higher-income riders land developers will not be focused on ferry-oriented development. Attention is focused elsewhere and as a result the water transit network struggles to maintain itself. Requirements for subsidy provision for rail operators linked to their efforts toward connectivity could be a path forward.

A major intervention by a state agency may be required to cut-through. If this were to be achieved, a service that carries commuters, student and tourist travellers in significant numbers, and that can play a key role in urban regeneration along its route, should be viable.
in the long-term for the benefit of the city. Such a breakthrough might be difficult unless a policy entrepreneur emerges with sufficient power to make a change. It will also be difficult if the landholders along the river itself fail to see what is happening as ferries spur on urban development in other cities. As middle-class groups increasingly use rail in the city there may be a shift toward ecosocialisation (Low & Gleeson 2001) within Bangkok’s transport policy which may serve to create the conditions necessary for such modernisation of water transport and its inclusion within the changing nature of Bangkok’s transport preferences. But if Bangkok’s institutions remain focused on megaprojects then small-scale efforts such as a ferry modernisation program may not gather sufficient support. Further, the lack of meaningful activity in developing interchanges in Bangkok, despite plans that put forward commitments to do so, suggests problems of agency and implementation in the cities institutional frameworks that need to be addressed not just for water transport but for all public transport modes.

A key consideration is land development. In Bangkok transport development not only fuels the construction industry but has a direct impact on land development. A few large development consortia control much of the activity in Bangkok and have also been entrusted with developing the new mass transit lines. This development trend sees those rail developments considered as transport and land use projects, not just as public transport investments, the consequence of which has benefits for potentially creating a more cohesive urban structure. But this rail-based growth coalition is politically powerful and marginalised groups and small operators like the Chao Phraya Express are unable to provide a meaningful alternative around ferry-oriented development at this point in time. Efforts toward TOD are often stunted in Bangkok due to the tightly controlled and highly speculated land around terminals that is concentrated amongst this small group who focus almost exclusively on high
yield condominium development. As a result, organic mixed development at stations with service and amenities are not usually supported. Planned mixed used efforts are also problematic with no regulations stipulating land uses mixes such as retail or affordable housing. Furthermore, there is the mentality to install the rail service first and then seek retail operators, which is a sub-optimal arrangement that does not capitalise on station infrastructure and foster a mixed used environment. Such impediments are threats to viable interchange facilities despite their critical importance in facilitating intermodal connections.

If there is one positive there has been a perception shift toward public transport in Bangkok which occurred with the introduction of the urban rail networks. Boat transport has not gone through this perception change but there is much potential. A renewed focus on river front living and shopping and riverfront esplanades for leisure walking may help shift attitudes. Recent efforts and trials of canal and rail connections show promising signs with strong equity dimensions (Thammasat University 2015a), but the potential for land value uplift is also large if the river can become a provider of mobility for the middle and elite classes. Perhaps the boat service cannot survive unless it is placed in a discourse of economic development, similar to other cities, where ferries are often not justified on their own, but within the context of other roles they perform such as economic development, tourism and city branding (Tanko & Burke 2016).

There are several limitations to this study. Firstly, only a limited set of interviews were conducted, and alternative viewpoints may be gleaned by speaking to individuals in the agencies with less direct involvement in transport planning in Bangkok. Secondly, and most importantly, only planning experts and institutional actors were consulted; opinions of transit users were not incorporated. Further research could fill these gaps and also study the
catchment of rail in Bangkok to assess the specific characteristics of rail stations to better understand the facilitators and barriers of rail and ferry integration in Bangkok.

Acknowledgements

Michael Tanko is the recipient of an Endeavour Fellowship to undertake the current research project in Bangkok [5360_2016]. Matthew Burke is the recipient of an Australian Research Council Future Fellowship [FT120100976]. We are grateful to those who participated in the research. Special thanks to Agachai Sumalee and other colleagues at King Mongkut’s Institute of Technology and Thammasat University who assisted with the study.

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7 Conclusion

7.1 Introductory comments

Chapter 7 seeks to summarise the main findings and contributions of the research, reflecting on how the results compare with the relevant literature introduced in Chapter 1. The aim is to provide a synthesis of the results with minimal additional information beyond what was provided in the published and submitted papers. The structure of this chapter is first a summary of the contributions, second a discussion of the finding of the research addressing the theory established in the introduction, and finally an identification of the limitations of the current research and suggestions for further research avenues that may serve to build on the current findings.

7.2 Contributions

The papers that comprise this thesis together have provided the first holistic study of the planning and operations of urban linear ferry systems worldwide and their value to cities and passengers. Only single studies have previously been reported in the literature and this was the first attempt at a more systematic approach using multiple methods to answer key research questions about this emergent mode.

A large number of the contributions of the thesis are conceptual, revealing how and why such systems are being planned and implemented. This adds to the present literature on transport planning in key ways. Firstly, Chapters 2 and 3 were the first published pieces of work to benchmark contemporary waterborne transport. This part of the research effort explored the circumstances in which water transit has been developed and what political and planning processes were influential. It therefore built on the work of scholars such as Weisbrod and Lawson (2003), Thompson (2006), Sipe and Burke (2010) and Burke and Sipe (2013) who highlighted the potential for urban waterways to be used more actively in an urban transport capacity via a greater role for ferry services. It revealed that in fact these services contribute more to cities than transport functions alone, providing key insights into the value such ferry
systems offer in terms of economic development, and therefore offering insights into their future planning and development.

This thesis also addressed the issue of the changing roles in transport planning and how this has been reflected in how decisions are being made. Through the case study of Brisbane, it was shown that there is an emergence of urban growth coalitions and policy entrepreneurs who have often taken a major role in driving transport advancement in cases where transport innovations have developed. In the case of urban ferry systems, it was often the case that such policy entrepreneurs were critically important in progressing the concept, especially in cases where traditional transport modelling indicated that such systems were perhaps not feasible. In many cases this required a calculated risk to be made and a demonstration of the benefits to be realised. These findings therefore contribute to the literature on how transport innovations in cities emerge and some of the conditions and prerequisites that aided in such developments, and built on the studies of Feitelson and Salomon (2004), Innes and Gruber (2005) and others who have previously conducted studies documenting the political, social and economic processes involved in transport policy development.

The next set of contributions were both methodological and applied. Chapters 4 and 5 provided the first empirical studies that investigated the usage of ferry systems using smart card transaction data. Though others have pioneered these research approaches (Agard et al., 2006; Morency et al., 2006; Pelletier et al., 2011; Ma et al., 2013; Utsunomiya et al., 2006; Park & Kim, 2008), this research was the first to apply them to urban ferry systems. The methodological advances were stated in the first published paper showing how to analyse the types of ferry fare transaction data that is produced in the Brisbane system. The applied results clarified key issues that remained somewhat contested in terms of how urban ferries are used, demonstrating that for the Brisbane system the majority of trips were linear, parallel to the riverbank, and not just single-stop cross-river trips. This study was therefore the first to show that the linear nature of such systems is actively being used by passengers and thus demonstrates the applicability of this model of operation. It revealed key origin and destination patterns for the Brisbane system and showed what advantages this approach provides for system planners. This study proves that the urban ferry system can be an important piece of city-wide transport infrastructure.
One of the most significant contributions of the thesis is in demonstrating that urban ferry users exhibit excess travel in their journeys, as was shown in Chapter 5. This paper for the first time confirmed and quantified the assumptions of others who have suggested that water transport may offer a ‘premium’ amenity value for users (see Weisbrod and Lawson, 2003; Zuniga et al., 2013). The results also provide further explanatory support to the work of Tsai et al., (2015) and the New York Economic Development Corporation (2013), which both found significant value uplifts around relevant ferry terminals in Brisbane and New York, respectively, suggesting some preliminary explanations for differences between FOD and TOD.

Finally, the case study of Bangkok provided the first look specifically at the operation of the Chao Phraya Express Boat service and its future within the context of a transit modernisation program currently underway in Bangkok. It has therefore added to the existing literature on transport planning in Bangkok, bringing to greater attention the local urban ferry systems and its potential. There are a number of cities worldwide that are currently considering such a system, and the paper’s findings will therefore contribute to knowledge that will allow those cities to make an informed decision about the applicability of such a system to their city. The paper therefore builds on a very small but growing body of literature on the development and modernisation of indigenous water transport systems (Utomo & Mateo-Babiano, 2015).

Currently, three papers have been accepted for publication from this thesis, with two more in review at the time of writing. The study on Bangkok forms the basis of a presentation in a plenary session of the Transportation Research Board’s Annual Meeting at the January 2017 Conference in Washington, D.C.

7.3 Discussion

7.3.1 Changing role of transport planning

The introductory theory highlighted the general shift in transport planning practice from a predominately technical-rational ‘predict-and-provide’ style, towards a more consultative process incorporating a wider variety of transport interventions. In the research component investigating how urban ferry system were introduced, it was found that while such changes
were evident, there were in some cases significant differences in the degree to which this change has occurred. Some cities showed more progressive polices toward accessibility and sustainable mobility goals, while others did not. It should be noted that while more in-depth studies of the planning and operation of systems was possible in Brisbane and Bangkok, for other cities this level of detail was not possible, as will be discussed further in the limitations section.

In Brisbane, transport planning has undergone a transformation that was strongly embedded in the social and environmental movements of the 1960s and 1970s. As mentioned in the introduction, protests against a planned highway turned out to be a watershed moment that empowered the community and led to the formation of the Integrated Regional Transport Plan (Queensland Transport, 1997), which proposed a more balanced transport future including expanded bus and rail networks. As it turned out, this history was crucial in laying the foundation for the acceptance of the urban ferry system that followed. As mentioned in Chapter 1, the idea for a linear ferry system was at the time unfamiliar, and the key transport innovation theory of Feitelson and Salomon (2004) suggested the need for technical, political and social feasibility for a system to be successfully developed. The issue of social acceptability was therefore in some way ‘prepared’ for the welcoming of ferry services by the transport planning shifts that had occurred in the city. In effect, public transport investment was more accepted, including investment in the existing cross river ferry services, although they were largely underappreciated at the time. Ferry services therefore began to fit within the developing sanctioned discourse of transport planning in Brisbane and major reorganisation gained acceptance, even though it meant accepting a certain degree of risk.

In the case of Brisbane, key personnel in the local bureaucracy acted as policy entrepreneurs for the concept. The idea also resonated within the context of the urban redevelopment strategies that occurred in the wake of Brisbane’s hosting of the 1988 World Exposition. In particular, new strategies to accommodate growth in key strategic waterfront locations, particularly New Farm, Teneriffe, Bulimba, Milton, Toowong and eventually Hamilton, also aided in this development agenda. The mayor’s very public policy platform of a ‘river city’ also allowed such plans to be implemented at the highest level in the city.
However in contrast, in Bangkok the situation of transport planning has been very different. No such reconceptualisation has yet occurred, which has impeded development and modernisation efforts in its transport network. Unlike Brisbane, which progressed through to a more balanced form of transport provision in assisting public transport, Bangkok is still in the phase of finding the right balance needed to support a multimodal transport network. Bangkok has begun an expansive new program of rail expansion and has also implemented a short-lived experimentation with BRT. However, the indigenous water transport system is for the most part yet to be considered within such visions. The challenge remains to include all modes, including the often neglected water and bus services which carry the bulk of the commuters, and to reconceptualise these individual efforts in a mutually supportive environment. Bangkok is often characterised by ad hoc piece-meal decisions about public transport which are preventing this fully scoped, multi-modal network from emerging; the kind of network within which the ferry system may play a small but significant role. Without a re-visioning of the kind that occurred in Brisbane and without a policy entrepreneur or entrepreneurs that might champion water transport modernisation, it is hard to see how a step-change in the Chao Phraya Express’s fortunes might occur.

Acceptance of the need for, and benefit provided by, public transport has therefore been set back in progress in this context. Unique political barriers have also meant that large scale top down implemented megaprojects based on ‘predict and provide’ models remain the norm, with public participation in projects still in its infancy. As noted in Chapter 6, there is also the key factor of the strong links between rail development and land development in Bangkok which has prevented other forms of transport from being recognised. Urban ferry services, as well as bus services, have therefore struggled to develop in line with highway expansion, and more recently, rail expansion plans.

In terms of the mentality change toward public transport, Bangkok is only now beginning to transition into an acceptance of the role of mass transit in the city’s transport hierarchy. The first mass transit rail was initially considered an unnecessary eyesore, but after six years it had established itself as not only an accepted part of Bangkok’s transport system, but due to its highly visible nature, has become an icon of Bangkok. Rail is now widely acknowledged as being beneficial and much quicker that the congested road system. As Richardson and Jensen (2008) observe:
The Sky Train has become ‘accepted’ in the modernist view of Bangkok’s streetscape, a particular mobility system has become almost stealthily hegemonic, becoming the ‘norm’ and increasingly the desired transportation solution of an urban elite that it has partly produced. (Richardson & Jensen 2008, pp.228–229).

Richardson et al. (2006) have also even characterised the system as serving to create a new elite mobility system where the sky train is seen as a modern contrast to the characteristically unorganised chaos of the streets below. They see this as a segregating factor, due to the sky train’s use by the middle class, elites and tourists, which has further divided this new norm from the local ground-based transport system used by the poorer locals who cannot afford to use the sky train network. The link with urban elites and consumerism is identified by Ayuthaya (2005) who sees the rail system as an organ of capital flow where users can be effortlessly shuttled between condominiums and malls which are often directly connected to the stations (Ayuthaya, 2005, p.16).

However, while rail has engendered this attitude in the public consciousness, the indigenous urban ferry system has lagged behind, with largely the same vessels and terminals operating as when the service began in the 1970s, rendering water transport as underdeveloped, counter to the rising desire of the middle class for modern transport services. Richardson and Jensen (2008) explain this in terms of different ‘mobile subjects’ in cities and how they each have corresponding imagined mobilities. The focus on rail has been created for the imagined types of desired (middle and upper class) citizens, and planners and policy makers have sought to accommodate the imagined ways in which these citizens want to move in time and space (Richardson & Jensen, 2008). The mobile subjects of water transport users correspond with the imagined mobility of passengers separate from rail passengers, in a form of utilitarian but undesirable and unsafe mode of transport. These transport users are therefore left out of the prevailing dialogue which seeks to predominately provide for rail users. Sintusingha and Mirgholami (2013) highlight the local saying toi lung lhong khlong or ‘to go back into the khlong’ meaning to reverse into the now denigrated, obsolete state or past, to illustrate the attitude of many modern transport users in Bangkok and their reluctance to ‘go back’ to using the river and canal network for transport. (Sintusingha & Mirgholami, 2013, p.125).
In the case of Bangkok then, urban ferry systems have therefore not yet demonstrated their value in terms of accommodating the needs of the increasingly demanding urban elite and also stimulating the economic development that rail has successfully done in the last decade. In some respects, it is a Catch 22 situation: there is no will to invest in water transport because it is seen as a sign of underdevelopment, inconsistent with the types of visitors and residents waterfront developers are trying to secure. But the only thing that will change this mentality is if there is some investment that transforms the rider experience, as has been accomplished in other cities.

In terms of the other cities in the study, such as New York and London, many lie closer to Brisbane’s example in the changing role of transport planning, with these cities having well established public transport systems and conducive social and political environments. In general, it was found that decision making processes have changed to reflect the lower influence of technical analysis and increased influence from policy entrepreneurs, in line with the shifts toward sustainable mobility in exploring how urban ferry systems were implemented. Within these supportive environments, political imperatives have guided the introduction or development of water transport in many cases. However, this may also be reflective of the lack of expertise and availability of technical-rational planning frameworks for water transport specifically (as will be discussed further shortly), which have necessitated a political decision be made in lieu of expertise on which to base such decisions.

7.3.2 Changing styles of planning

In terms of planning styles, there was an observed difference in the processes underpinning the ways in which urban ferry systems have been implemented. It was noted in the introduction that collaborative planning is a co-evolving process whereby all actors cooperate to solve an issue, often when there is a high diversity of interests and also a high interdependence of interests (Innes & Gruber, 2005, p.186). In the case in Bangkok, while there is intent to facilitate a more collaborative approached cognisant of environment and social concerns (in the form of ecosocialisation), there has been resistance to working in a collaborative way from those in existing positions of influence. Due to a long history of neoliberal competitive policies and resulting path dependencies there is resistance to changing existing power structures which would be required in a collaborative process. This
is a significant issue in Bangkok, where the status quo is likely to remain. Collaborative processes face serious institutional challenges to implementation where the current situation predominantly favours the replication of the same forms of transport developments.

The London context was different again, with the system being a private venture not subject to the investment of public funds. While the exact details of the decision making process of the private operator as to why they decided to invest in the idea remain unclear, the fact that the system runs largely unsupported by government funding (there is a small concession to use piers owned by Transport for London but no direct financial subsidy), suggests that the entrepreneurial thinking was sound. In this case the entrepreneur, after some trial and error, has developed a model that works, that is a high cost premium service targeted at a cost insensitive market. While it does work in London, this model shows that public transport is increasingly being diversified and offering new options instead of a similar offering between other modes, where the only decision making factors traditionally are travel time, reliability and punctuality. The success of London’s urban ferry service therefore was very much predicated on the premium value that was thought to exist in the service. Consequently, the identification of these alternative values is worthy of investigation in an attempt to understand the planning of such urban ferry systems and the value that they may offer to cities.

7.3.3 Revealed value of ferries

As has been demonstrated, such factors are increasingly important and one of the key questions of this research was what value an urban ferry system provides to a city. There have been previous theoretical studies posing this question, suggesting waterfront development opportunities and convenient transport to these locations, as well as the added benefits of travel amenity and comfort that ferry services may provide. The interviewees in the comparison study of world ferry systems in Chapter 3 also revealed similar perceptions and assumptions about the existence of such a premium. By using quantitative data analysis and looking at actual travel patterns it was possible to assess whether such values were actually reflected in what value water transit provides to a community. For example, a key question was whether urban ferry systems are serving simply a tourist role, or are they providing a valuable public transport service to commuters?
What was found in Chapter 4 revealed the value of the service in this capacity. It was shown that ferries are used in a linear nature and not simply as cross river services used occasionally by limited local populations with little geographically isolated benefit. The service is used like a river bus, as another public transport mode, and thus contributes this function and value to the city. Furthermore, the strong weekend use and infrequent journeys that were found suggest that the service also functions as a leisure and tourism mode, adding another facet. This suggested an amenity value that users were getting from the journey itself. Chapter 5 followed up this hypothesis and went further to demonstrate excess travel in journeys and showed a revealed premium that users attain in the public transport network in Brisbane.

In discussions with system operators it was found that economic development was the primary reason factored in urban ferry systems in New York and Gothenburg. As mentioned previously, there have recently been quantitative assessments looking at Brisbane and New York showing economic benefits around new ferry terminals, which suggests that such values should be included in future ferry service planning. Other factors such as tourism and promoting city image were also mentioned in Chapter 3 as additional benefits when considering a system in Copenhagen and Brisbane. While these factors are still theoretical and have not been quantified, such factors should not be ignored when planning ferry systems.

These findings show that there are additional values that ferry services provide. In this way we can start to assess whether the reasons and justification for installing such systems are reflected in the operations of systems themselves. The question then turns to how best to capture these additional factors in decision making processes when considering urban ferry systems.

### 7.3.4 Incorporating new values in traditional decision making frameworks

As noted in the introduction, transport investments are increasingly being seen in a wider context than passenger transport alone (OECD, 2002; Venables, 2016). These additional roles can be beneficial in increasing the feasibility of urban ferry systems in particular, as it was found that these secondary roles and benefits were found to be significant. This research revealed that under current rational analysis procedures, ferry systems were usually
uncompetitive with other modes. A notable example was in Copenhagen, where a rational planning process weighing the costs and benefits of such a system concluded that a ferry service did not make sense under current economic modelling processes. Despite this, political actors overrode this quantitative assessment via an instinctive assessment. Therefore, there was a sense that the system would provide benefits that were not intrinsically included in the traditional CBA framework. Perhaps the most pertinent of these benefits was the suggestion that urban ferry services may contribute to economic development objectives, including waterfront rejuvenation programs.

As mentioned, there has been some progress in incorporating economic value in justifying a ferry service in New York. At the core of the proposal was forecasting done by a leading organisation, the New York Economic Development Corporation, which planned the system on an economic basis with specific modelling conducted which forecast waterfront economic development. It is one of a suite of plans to open up the East River in New York to new development opportunities, much as the processes of the ‘river city’ dialogue used ferries in Brisbane as part of wider city planning efforts. But in other cities, while interviewees indicated that such economic considerations were important, such specific modelling for this was not apparent. It seems instead that such knowledge was assumed. Again this perhaps points to a lack of experience in ferry system development and expertise in planning, where the same evidence in other TOD modes has been more successfully incorporated in formal justifications in planning transport projects for these other modes. As mentioned in the introduction, CBA and other models in their current form may not effectively capture benefits such as economic development if these are not included in the model. This may explain why in some cases, where a CBA was conducted in assessing water transport systems, the predicted benefits that would accrue did not outweigh the cost of development. However, the systems that were studied did proceed, suggesting the decisions were not solely based on rational planning processes, but that other factors were also important.

Apart from the lack of planning expertise in urban ferry systems, another factor that may contribute to this decision making process is the image of water transport. As noted in the introduction, Richmond (2006) has suggested that ferries may be seen as being popular based on image and political reasons, rather than the transport function they provide. As was shown in the history of Brisbane, a political champion did work to co-opt others in the bureaucracy
Despite little concrete evidence or modelling of the benefits of such a ferry service. As it turned out (as it also did in Copenhagen) such a gamble paid off. But in other circumstances such image focus and perhaps mode ‘fetishism’, may lead to disastrous outcomes that override transport functions and result in a waste of public funds (Hall, 1982). However as also noted in Chapter 2, a contributing factor to the introduction of the CityCat system in Brisbane was the influence of considered risk taking, suggesting that such risk taking is perhaps needed where quantifiable justifications are not currently available. For example, it is evident that water transport could potentially increase economic value in Bangkok, but the current fleet’s underdevelopment has hindered this potential so far. Some efforts are being made to trial modern boats and technologies, and this may be what is needed to demonstrate water transport’s value. However, economic and transport benefits need to be considered carefully. Cervero et al. (2004) contend that transit is generally a complement to, not a cause of, development. And specifically in terms of urban ferries’ economic benefits, value uplift data should be interpreted cautiously, and may be misleading. Sipe and Burke (2010) suggest that the terminals may not always be driving this development directly, but instead it is the riverfront location that ensures the success of the development.

### 7.3.5 Intangible benefits

While economic land development and regeneration benefits have made some progress toward incorporation in the decision making process of ferry transport, more intangible benefits may prove to be more problematic in analyses which still overwhelming favour quantifiable inputs and outputs. This thesis suggests a few key factors that ferry systems contribute in this regard. The first is the amenity value that urban ferries contribute. As noted previously, a main consideration in traditional transport planning is travel time. However, with changing user travel patterns and preferences, the comfort of journeys and the amenity the travel incorporates are increasingly important factors in travellers’ commuting choices (Jain & Lyons 2008; Zeid 2009; Kent 2016). However, how to incorporate this into a decision making process is problematic.

As was highlighted in the theory, travel time can be broken down into two streams: active and passive enjoyment of the journey (Mokhtarian et al., 2004). In terms of active enjoyment where passengers are able to conduct work whilst on their journey, there is perhaps the
possibility that instead of calculating the hours lost in productivity on transport, this can be amended to consider productive time and how this may be balanced with the cost of travel time. In this way the benefits may be able to be quantified into an existing decision making framework that could accurately reflect the amenity value of water transit, in comparison to other modes which perhaps do not allow work as easily. Benefits of tourism and promoting city image are values that also may be estimated in monetary terms.

The second aspect, passive enjoyment, is potentially more difficult. While ongoing research suggests that buffer times, relaxation and exposure to pleasant environments may result in psychological and mental wellbeing benefits (Jain & Lyons, 2008; Morris & Guerra, 2014; De Vos & Witlox, 2016), the literature on excess travel in commuting is limited currently to a theoretical basis that simply suggests these factors should be considered, stopping short of suggesting any workable mechanism for doing so. Whether this means a mechanism to quantify these benefits into existing decision making processes or the need for new processes has not been established. However, when considering water transport, such developments may prove to be helpful in providing a more even assessment of the benefits of the mode relative to others.

In any case will incorporating this amenity value be successful? Often the intent is to make public transport more attractive to entice travellers away from private car use. However, research has shown that often this has had little impact, with users consistently rating on-board amenities as low compared to traditional service metrics such as travel time and reliability (Riders Alliance, 2016). It seems the benefits are only enjoyed by those existing users. However, there have been contrasting studies showing that with better amenities on board, users perceive their travel time to be shorter and less burdensome (Lyons & Urry, 2005). It is also worth noting that excess travel and amenity benefits are usually not reflected in shorter travel times. For instance, for a journey of less than 20 minutes, it has been shown that people do not care so much about amenity and comfort, presumably as this is a relatively short time to endure. But it may also be the case that this short time is not long enough to do anything productive that a more comfortable journey would allow, for example, seating that would allow work to be done. Accordingly, when travel times are over a certain threshold, on board facilities become a significant factor (Jain & Lyons, 2008). Perhaps the valuing of amenity in public transport is a case where users do experience these benefits but they are
more ‘hidden’ and taken for granted, against studies where commuters are specifically asked their value preference for public transport services in stated preference surveys, where the value of common transport metrics are more often reported and emphasised.

Such amenity values should be carefully planned in order to prevent them from becoming an easy fix solution. As noted in the introduction, there can be a tendency for CBA to skew the results, in that one mode of travel is ideologically preferred over another. As has occurred in cases of light rail being preferred over buses, it may also be the case that ferry systems are preferred over another more suitable mode. Another possibility is that the concern for comfort may be overemphasised and in effect serve as a distraction (or justification) to avoid implementing more meaningful but difficult to achieve transport system overhauls. For example, the recent renewed focus on technology in New York City buses has been criticised as diverting attention from more efficient service routing issues (Riders Alliance, 2016). Bangkok’s infrastructure focus on modern rail systems may also be a continuation of Bangkok’s reluctance to implement much needed structural reform. Both of these examples would lead to much better outcomes by addressing the problems underlying issues instead of applying surface fixes. Again, while amenity can be important supporting factor, such issues should not override the provision of an effective and efficient transport system.

In any case this disconnect between the imagined ideals of a ferry system and the value that actually results is an evident issue. In cases where there is little evidence to inform decisions, and decisions are instead made in purely political and instinctive ways, the assessment that ferries are a ‘transport of delight’ may be apt. To counteract this, there is the need to link the imagined ideal and demonstrated value through a generalised framework to inform policy makers on the specifics of planning urban ferry systems. As noted, some progress has been done in this effort in New York’s transport service. But other factors that define an urban ferry system also need to be specifically included in such a proposed framework in order to more effectively plan for water transport systems.

7.3.6 Ferry transport modernisation

What does this all tell us about how ferries are planned currently and may be planned for in future? In Chapter 6, this research looked at how future boat services may be incorporated
within a developing transport network. The still unfamiliar nature of water transport services means that currently instinct has often shaped their success and the risks that come with this. In cases where there has been analysis, it has not been specific enough to take into account the differences in water transport. In Brisbane for example it was noted by the planners that ‘we had to figure things out on the go’ during the planning and implementation of the system.

In Bangkok there is the added complication of modernising an existing water transit service which has an underdeveloped image. Incorporating justice is also an important factor in Bangkok, which has a history of, and an ongoing trend toward, inequality in transport provision. The transport dialogue is still largely shaped by the imperative of providing unlimited personal mobility, and therefore most focus is on reducing on-street congestion in any way possible, and this usually results in more expensive and elaborate highway expansion plans. However, despite now having a mass transit public rail service that suggests reducing inequalities and providing a more balanced transport offering, the focus on rail alone in the future threatens to perpetuate a new era of inequalities and a continuation of infrastructural solutions. The challenge then is to turn around the perception of the underdeveloped water transport network and place it within a more balanced transport expansion plan that includes a greater focus on transport equity so that the investment in the new rail system, and the public transport network as a whole, can be fully realised.

7.3.7 Ongoing issues and challenges

While this research has documented many successful examples, there continues to be ongoing issues for implementing water transit systems in cities that have resulted in a number of notable failures. The current success of London for example was predicated upon the failure and lessons learned from previous efforts. The most significant was the River Bus project implemented in 1987. A number of key issues were at play in its failure such as the inability to use certain piers which would capture the tourist market and land uses around the developing Docklands not yet reaching capacity for a viable service. One of the partners of this previous effort was the person behind the now successful Thames Clippers service. The current incarnation no doubt benefitted from the lessons learned in how such a service could feasibly operate. The current business model of a premium service, subsidised by corporate partnerships and targeted at a business clientele, also coincided favourably with new riverfront, land development including at the Docklands area, as well as pier licensing.
arrangements to allow capture of the tourist market which was considered to be enough to cross subsidise routes and allow the overall service to achieve a modest profit. The service was also aided by worsening capacity issues on rail services and the desire for a more amenable alternative.

In Paris there was also the short lived Voguéo commuting service along the Seine. The service started strongly but there were a number of issues that brought an end to the two-year trial. Firstly, the frequency of services was not adequate to perform a functional commuting role, starting at 30 minutes and eventually being reduced to 15 minutes after passenger requests. The service was also not integrated into the wider public transport network and was costlier than a subway or bus ticket which in many cases offered equivalent, faster options. The lack of planning with other transit was also problematic as this limited the direct connections that could be offered by the Seine. This is a general issue with ferries which only offer limited direct waterfront connections and therefore in most cases depend on intermodal connectivity.

In Brisbane, after the success of the CityCat system there was a short-lived trial of a smaller, slower demonstration vessel, the Kitty Kat. However, this model of operation did not prove popular in Brisbane and the service ceased shortly thereafter. In addition to few examples, there are many more cases in which proposed urban ferry services did not capture the support or imagination of the commuting public. The focus on successful systems in this thesis may understate how difficult it is to bring such a transport innovation to fruition. As well at the predominant focus on success factors outlined in this thesis, such failures are therefore worth considering, as ferry services will not always fill the particular need. In many cases the timing has also proved critical where development of the waterfront, access issues, and passengers demand has not been supportive of a such a system. Planning of future service would therefore benefit from understanding such challenges in moving forward.

7.3.8 Key learnings for future ferry development

This research found that urban ferry systems do offer unique benefits to cities and should be considered in terms of the unique value they offer. Throughout observations and discussions with experts and it was revealed that there are other cities such as Abu Dhabi, Stockholm and Melbourne, amongst others, which are considering options for improved ferry services.
Melbourne has just finished a trial of a service to link key satellite cities to the main CBD area. Urban ferries are also being discussed in coordination with city plans to clean up urban waterways and use them in a transport role in cities such as Manila, Jakarta and Chicago. If successful, these plans could replicate Brisbane’s success with its river re-orientation plans and urban ferry system. In this way, water transit should not be seen as a quick fix solution but one that offers city-wide benefits to a multi-modal public transport network. In cities that have developed such systems it has been a modest contributor to the overall trip task, but when planned well can fit a specific need. Urban ferries should therefore be considered as a complimentary mode within a wider transport network, offering additional benefits, not a standalone mode warranting comparison to mass rapid transit systems. This seems especially to be the case for water transit which has limited routes and capacity and requires interchange to work effectively.

While there are considerable advantages, such as largely unobstructed rights of way and where waterfront development opportunities exist, this is not to say that such systems will be suitable for all circumstances. But where it is a relatively cost effective and flexible option tying in with waterfront development plans, it may be suitable. As shown in this research, currently the decision making processes that could accurately assess the strengths and weaknesses of contemporary urban ferry systems are not yet well developed. What is needed is a merging of technical with social and urban planning expertise when considering such systems. It is possible that there may be values of water transport that are still unknown, as was suggested by the disconnect between justifications for implementing a ferry system and the outcomes. Under such circumstances how can we exactly identify if we have succeeded in achieving those goals if they have not been defined? This also runs in parallel with the efforts toward modernising water transport in places where such services are often not a serious part of the dialogue when discussing future transport options. It is not likely that a comprehensive detailed plan that suits all contexts will be achievable or even desirable, as shown in the problems associated with transport policy transfer as highlighted in Chapter 6. But this thesis does suggest that that a move toward a guiding framework is required and would assist in more efficient transport planning outcomes when considering urban ferry systems, and at least offer a reference point from which to work.

There are a few considerations that could be incorporated in such a framework. For example, in effective ferry systems, it was shown that trials often started small to demonstrate value
and show services were feasible. In Brisbane a four vessel system has expanded to 24 vessels currently. In New York, a three year trial was similarly able to demonstrate that users were both willing to use the systems and that the intended property value increases were realised. Secondly, it was shown that often the role of urban ferry services changed over time. For example, a service initially focused on supporting river development and tourism in Brisbane has evolved over time to become an important part of the everyday commuting network. In New York the initial trial has since opened the way for city-wide expansion and a changing role into a more dedicated commuter service from the economic and tourism focus that was initially promoted. Such changes should be accommodated in any generalised planning framework. Thirdly, there is the benefit of the inherent flexibility of a ferry system which can add new terminals and expand relatively easily, and even change terminals and add vessels gradually, which was seen as an advantage in the success of urban ferry systems in some cases, such as in Brisbane and New York.

7.4 Limitations of the research

This research program has a number of limitations. Firstly, Chapters 2 and 3 involved a selection of cities with characteristics that met the definition of the object of inquiry and interviews with informants regarding the planning of each system in each city. Due to time and budget constraints and there being a single researcher, only a limited sample of cities and a small number of officials or operators in each city could be interviewed in order to contribute to the data underpinning these chapters. Secondly, Chapters 4 and 5 relied on smart card transaction data, but there were some notable limitations. In the form that it was released for research by the relevant government department, it did not allow us to explore the type of traveller (i.e. Adult, Concession or Senior citizen travel card), and such data cannot reveal anything of the purpose of trips recorded. The smart card data was able to reveal a ‘premium’ for ferry versus bus services in Brisbane, but the analysis was restricted to one key origin-destination pairing within the city. Further, the data used does not allow us to reveal whether these benefits were utilitarian, in the form of helping ferry passengers be more productive on their journeys, or whether the excess travel identified related more to the aesthetic benefits that ferry systems provide. Details about users are also limited in the data. In Brisbane’s transport system, the registering of personal details is voluntary, and so data on the socioeconomic status of passengers is not available. Such demographic data would prove to be a better resource for identification of how excess commuting is differentiated between
user groups, if such data were to be released in future. Currently, the data available is also limited to a six month slice, and so longitudinal studies may also be worth pursuing with future data sources. Finally, there were also some limitations in the reporting of other data sources due to commercial-in-confidence issues with private operators of services, such as Transdev in Brisbane and the Thames Clippers service in London. Any other limitations were noted in the relevant sections of each chapter.

7.5 Further research

There are a number of further research agendas that this thesis suggests. The findings of Chapter 5 indicate that some external benefit is being derived by passengers who exhibit excess travel. There is therefore the need to find out what comprises such benefits within ferry transport systems, either in terms of aesthetic benefits or other contributing factors, through qualitative survey questionnaires or otherwise incorporation of socioeconomic data of passengers.

This thesis used smart card transaction data in two studies using a subset of the entire dataset that is captured for one city. There is therefore the opportunity for further analysis using this data and other sources that can supplement it, as well as the data from other cities should such data become available. Currently, Brisbane is the only ferry system that offers available data linked to a smart card data system. Gothenburg and Copenhagen do offer such data but it was not available during the writing of this thesis. London is starting to incorporate the Oyster Card for water transit services. Such empirical analysis of other systems could allow comparative studies to identify differences in ferry ridership patterns by season, as well as the impacts of weather, land-based congestion effects or other possible variables to offer a more holistic view of how water transit is being used to assist with planning and management of future systems.

Furthermore, as noted previously, the smart card data used in the thesis is limited and does not provide disaggregate data on incomes and the identities of travellers. Such analysis could provide an interesting analysis of particular submarkets e.g. tourists or students. While some CBA processes do consider heterogeneous populations, further studies could also consider individual preference in the transport planning process, if this data is available. This could also start to build further literature on the nature of excess travelers and how this can be incorporated into transport planning frameworks, and in the specific case of water transport.
This research indicated that land development was often a key element in developing water transit. A future focus could the further analysis on property value effects of ferry terminals and infrastructure, including across different urban contexts. This could also lead to models of possible value capture funding and financing schemes to help pay for water transport development capital costs.

In terms of vessels and terminal infrastructure there is the need for research regarding factors such as the importance of customer preferences, use of facilities, improved design for disability access, and resilience to flooding and disasters. Operational considerations also warrant further research, such as investigating the most efficient operating route configuration, staffing considerations, and ways to increase terminal boarding and alighting efficiency. Furthermore, there is the opportunity for more research on ideal terminal spacing and stopping patterns and how FOD differs from TOD and how terminals and surrounding infrastructure can be better planned. As more vessels are added to waterways there is also the need for studies on the possible environmental and ecological effects, and also the interactions with other waterway users such as recreational boat users and rowers in Brisbane and other cities.
7.6 Post script

During the writing of this thesis many current, ongoing issues were identified in the planning and operation of urban ferry systems. There appears to be growing interest in this emerging mode of urban transportation evidenced by the increasing set of publications from around the world looking at the prospects of urban waterways, including in Australia (Sipe & Burke, 2010; Burke & Sipe, 2013; Zuniga et al., 2013; Tsai et al., 2015; Sandell, 2015), North America (Soumoy & Sweeny 1998; Weisbrod & Lawson 2003; Thompson et al. 2006; Wang & Lo 2008; Kamen & Barry 2011; Bruzzone et al. 2012; Camay et al. 2012; Rahman et al. 2016), Asia (Ceder 2006; Hossain & Iamtrakul 2007; Thammasat University 2015; Utomo & Mateo-Babiano 2015; Mateo-babiano 2016; Boonlong 2016), and Europe (Mathisen & Solvoll 2010; Stenius et al. 2014). In the current trends and context such ferry systems may be viewed as a fashionable modern addition to a city. The challenges in modernising the boat service in Bangkok, however show a different context, where water transport does not fit the local ideal of rail users who are the new idealised norm. Where water transport fits within this transport dialogue of cities is still being developed and refined.

There is also a noticeable trend in river restoration and repurposing programs in cities around the world. This has been driven not only in terms of environmental concerns but also considering how waterfront spaces can be used for recreation, particularly in Bangkok where there is limited public space. The current plan for a riverside promenade in Bangkok is the topic of ongoing research by the author. There is also an increasing interest in water taxis and autonomous boats as new technological solutions are constantly being proposed in water transport, specifically for urban scale commuting. It is the hope that this thesis and its focus on transport and land use planning will be useful to other multi-disciplinary research in urban waterborne transport and can assist with the better planning and delivery of such systems in the future.
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