MODELLING A LAND VALUE CAPTURE APPLICATION IN CHRISTCHURCH, NEW ZEALAND

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Contents

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Abbreviations:

AMM	Alonso, Muth, and Mills model
BRT	Bus Rapid Transit
CBD	Central Business District
CCC	Christchurch City Council
CEPAC	Certificados de Potencial Adicional de Construção
(Certificates of additional construction potential)	
CIV	Capital Improved Value
GIS	Geography Information Systems
HRT	Heavy Rail Transit
LINZ	Land Information New Zealand
LRT	Light Rail Transit
LVC	Land Value Capture
LVU	Land Value Uplift
MBIE	Ministry of Business and Innovation
MTR	Mass Transit Railway
ODC	Ørestad Development Corporation
PRT	Personal Rapid Transport
QV	Quotation Valuation
RDPI	Redevelopment Potential Index
T-IMPROVE	Transport-Investment and Measurement of Property Value Enhancement
TIF	Tax Increment Financing
TOD	Transit orientated development
UDS	Urban Development Strategy
ULV	Unimproved Land Value
WMATA	Washing Metropolitan Area Transport Authority
WTP	Willingness to Pay

Introduction

Cities around the world are looking for more and more innovative ways in which they can increase their competitiveness, and improve their liveability. Unfortunately for many cities they are faced with a cycle of car dependency, limiting the ability for productive growth and for more sustainable urban outcomes. The focus for most cities have shifted towards how they are able to provide well planned public investment in transportation infrastructure. For most cites the interests is in moving away from vehicles and towards mass transit. Mass transit however is exceedingly costly and few projects are followed through into the implementation stage. New Zealand cities are no different, and in many regards worse when it comes to the provision of mass transit. These challenges are escalated due to the expectations of many urban residents to be provided better and more frequent services.

New Zealand struggles to afford large infrastructure projects, particularly the kind that will improve productivity and increase economic viability. There is limited means or capacity to invest in the scale of works likely to make substantial difference. For this reason the cities of New Zealand need to look carefully at what funding opportunities are available to them and how it is possible to innovate in transportation funding to start providing economically productive, and smart infrastructure investment.

Land values act as a barometer for good provision of infrastructure, and new ways of capturing this value is possible to be undertaken so cities can thrive. This thesis examines the application of Land value uplift and capture as applied to an urban setting in New Zealand. This works through international examples and simulates this in a Christchurch setting.

Research Problem

Cities around the world face an ongoing dilemma of an over reliance on private automobiles for transportation, causing economic inefficiencies, negative impacts on the local and global environment, and adverse impacts on the sociality of urban spaces. Faced with this, an alternative transport future needs to be found; cities need to rise above car dependence and provide a transport future that can move them forward, as opposed to the grinding halts of congestion. Mass transit schemes are surely the solution to this, and implementation of fixed line modes, be it light rail, heavy rail, or bus rapid transit are being built and expanded at a pace not seen before. Whilst this is the case in many places, some cities still lag behind; funding becomes scarce and projects, no matter the benefits they will bring, never leave the pages of planning documents. The core problem that this research thesis sets to answer is whether the land value uplift that results from transit can be used to fund transit through land value capture in the car dependent city of Christchurch.

Research Hypothesis

The hypothesis of this research is that a land value capture method can be employed to fund future mass transit in New Zealand cities.

Research Objectives

This research has several objectives to achieve in order to test the proposed hypothesis.

1. To identify through a literature review the potential for land value capture application within a New Zealand context and legislative framework.
2. To establish the best land value capture application for use in a New Zealand context.
3. To estimate land value uplift on two simulated transit scenarios.
4. To develop an argument as to the potential for a land value capture application to be used to pay for the simulated transit options

5. To compare the likely built development outcomes as a result of the simulated transit implementation scenarios.

Literature Review

Introduction

This research is primarily focused on the potential for car dependent cities in New Zealand to find innovative financial mechanisms to overcome automotive dependence. For the cities that are the subject of this research, transport improvements are becoming increasingly difficult to afford, yet due to their car dependent nature, these improvements are increasingly necessary. The modelling and the framework are tested on a Christchurch City example. Given this is the city chosen to be the spatial focus of the research, the literature review considers more broadly the problems, scenarios, and solutions that can be found within other similar urban situations, focussing on research works studying cities in Australia, New Zealand, the United States of America, developed European and Asian urban economies. Outside of these regions, research is less relevant and useful to a New Zealand situation, and hence the limitation to the similar urban economies.

For New Zealand cities, the need to innovate is crucial with respect to transport. The risk of under investment is hampering economic growth, driving house prices higher, and threatening the high quality of life enjoyed by residents (Drew, 2014; Sustainable Urban Development Unit, 2008). In order to do this however, significant understanding about the complex spatial relationships between land use and transport will need to be better understood. A guide from international studies is useful, as are studies within a local context that have been conducted to date. These will help to frame discussion on the matter (Kemp, Mollard, & Wallis, 2013; SGS Economics & Planning, 2007).

The aim of this literature review is to ascertain if land value capture could become a viable transportation innovation for New Zealand, and to uncover prior research that will guide the model assumptions used in this research. Some of the earlier literature that is pertinent to the Christchurch scenario include early theories of urban development (Alonso, 1964; Mills, 1972; Muth, 1969).

Modern day interpretation of these theories and similar studies testing relationships can be drawn on to help understand spatial relationships and likely scenarios, in order to build the model used in this research for the viability assessment of land value capture. The literature also helps guide the reader towards an understanding of the moral premise of land value taxation and the case for capturing the 'unearned increment' as referred to in early political economy literature (George, 1879; Ricardo, 1817). The review goes further, showing the present gaps in our knowledge about the capabilities of such a mechanism being applied to a New Zealand scenario (Grimes & Young, 2010; Kemp et al., 2013; SGS Economics & Planning, 2007). As with any theoretical framework, there is some research that does not support this, and there is a discussion on how this impacts on the development of the model and perhaps some failings of the model as it currently stands.

Automotive Dependency

The term "automotive dependence" was first coined by Newman and Kenworthy, (1989) in their book *Cities and Automotive Dependence.* This term is used by the authors to describe the process and effects of becoming car dependent and, as a consequence, planned for cars. Newman and Kenworthy assessed this by looking at several variables; the consumption of petrol, density and decentralisation, the use of public transport, and the provision of infrastructure for transport, and then used these metrics to define the level of dependence on automobiles for travel. Their work posited that cities that became very dependent on automobiles had a number of negative consequences of such dependency. Furthering their work in later books, they proposed more sustainable transit orientated development as a solution to automotive dependence (Newman & Kenworthy, 1999). Litman (2014) furthers the definition of automotive dependency by explaining that it refers not only to the effects of increased vehicle use, but also the associated land use changes that occur as a result of car dependency, coupled with a lack of viable or inferior transportation alternatives. Like Newman and Kenworthy, Litman concludes that transit is a solution to automotive dependence.

Private automobiles have a number of benefits but also numerous negative consequences. Few of these benefits extend beyond the user of the vehicle, whereas the result of automotive dependency has been shown through research as having numerous negative consequences, including, but not limited to:

Negative Environmental effects

- Localised air and noise pollution (Frumkin, Lawrence, & Jackson, 2004)
- Contribution to global climate change (Perkins, Hamnett, Pullen, Zito, & Trebilcock, 2009)
- Waste from production and decommissioning of vehicles (Sakai et al., 2014)
- Reduced streetscape amenity (Hillman, 1998)

Negative Socio-Economic Effects

- Congestion and subsequent reduced productivity (Newman & Kenworthy, 1989)
- Higher private transportation costs (Hillman, 1998)
- Increased burden on government finances (Hortas-Rico & Sole-Olle, 2010; Trubka, Newman, & Bilsborough, 2010b)
- Poor levels of service and quality for alternative transport methods (Litman, 2014)
- Increased urban sprawl (Kenworthy & Laube, 1996; Newman & Kenworthy, 1996)
- Declining high street retail and service centres (Dodds & Dubrovinsky, 2015)
- Reduced sense of place (Morris, 2009)
- Less community cohesion and neighbour interaction (Freeman, 2001)

Negative Health Effects

- Increased automobile crashes (Frumkin et al., 2004)
- Higher rates of obesity and associated morbidity (Lathey, Guhathakurta, & Aggarwal, 2009; Trubka, Newman, & Bilsborough, 2010a)
- Reported higher rates of mental illness (Morris, 2009)

Automotive dependence creates a self-reinforcing cycle of increased vehicle ownership, higher vehicle kilometres travelled, reduced travel options, and land use planning/policy that favours the car, as illustrated in Figure 1 below (Turcotte, 2008).

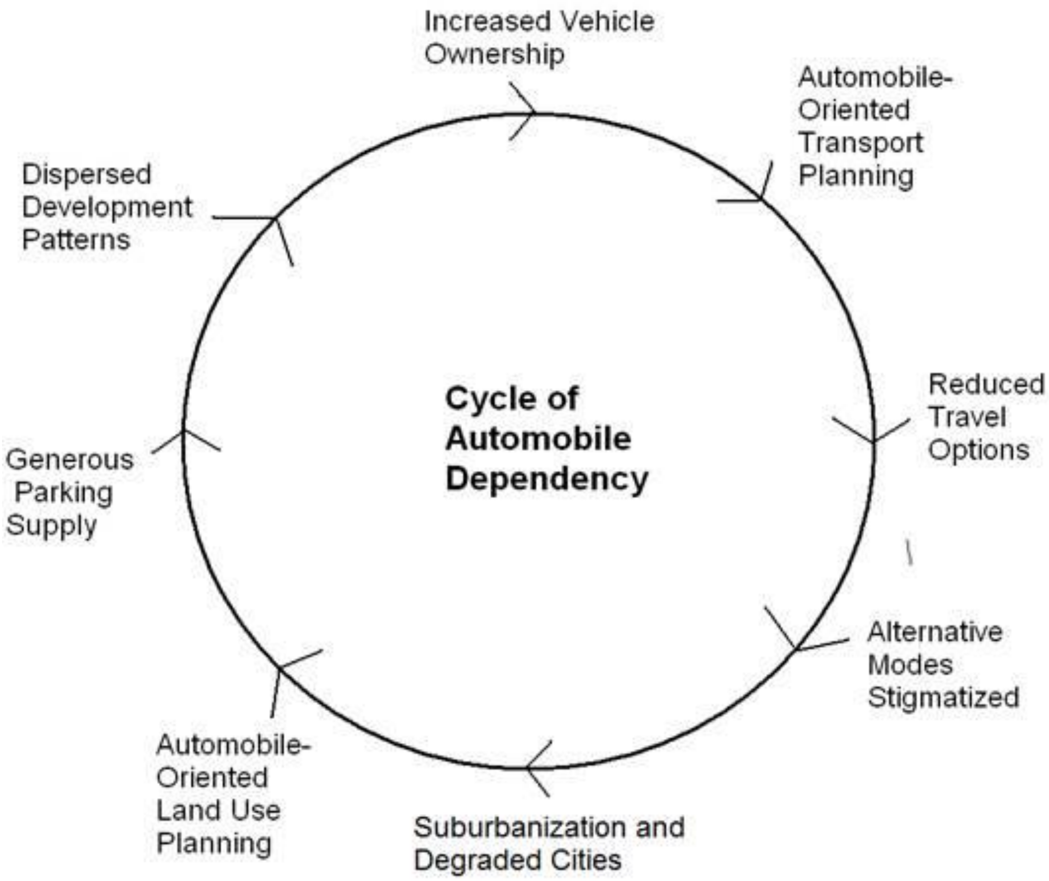

Figure 1: Cycle of automobile dependency. Retrieved from *http://www.vtpi.org/tdm/tdm100.htm* (Litman, 2014).

New Zealand cities, like many similar international examples, are facing the increasing and ongoing effects of automotive dependency and are seeking alternative futures. Threatened by the environmental, economic, and social ills of being car dependent, cities are looking to change their trajectory away from planning for dependency on private motor vehicles and towards multi modal transport solutions (Sustainable Urban Development Unit, 2008). Faced with changing social preferences and demographic pressures to provide alternatives, cities are now exploring options to provide, expand, or enhance their public and mass transit systems (Bertolini, Curtis, & Renne, 2009). Systemic automotive dependency has made many of these systems at odds with the current urban layout and innovative solutions to provide for change will be needed, particularly in land use and transport planning.

Transit Orientated Development

Transit orientated development (TOD) is an approach to land use and transport planning that focuses on delivering new development within walking catchments of transit services. Research has typically characterised TOD as having a mixture of uses, higher density residential development, a focus on walkability and pedestrian connectivity, a limited supply of parking, and higher quality urban design (City Of Austin, 2006). Most works recognise how these attributes are distinctly opposite to the urban form outcomes of automobile dependency described earlier, which consist of low density, car focused, and single use development trends. Many benefits have been attributed to TOD and thus this urban form has been appealing to researchers, planners, and politicians alike (Bertolini et al., 2009).

TOD has been found to be a popular planning solution as it is a response to current issues that are having significant impacts on the urban system. The strain on the urban system caused by increasing energy prices, the ongoing effects of congestion, the imminent threat of climate change, changes in socio-demographic profiles of housing tenure, increasing urbanisation, and increased interest in environmentally contextual and sensitive development are all factors contributing to this popularity (Pojani & Stead, 2014). The key to successful implementation of a TOD is to plan transport and land development concurrently and coherently so that each is delivering a fit for purpose that will complement the other. This form of development is easily done in brownfield and greenfield scenarios, particularly in comprehensive new town style development projects in Europe and Asia but is proving difficult in established urban areas, and greyfield development focused projects; those focused within established regeneration residential areas (P. W. Newton, 2006). As the popularity of the car increased in the 20th century, many transit systems were removed from cities and new suburban and exurban development was planned with the car as the only form of transport. Fixing this mistake is a likely to be a costly exercise, not least due to the massive cost of mass transit infrastructure (McIntosh, Newman, Trubka, & Kenworthy, 2013). To achieve an effective alternative to automotive dependency, a way to afford mass transit will need to be found.

Mass Transit as a response

Mass transit is the overarching term used to describe a transport solution where shared occupancy vehicles travel along fixed routes. The most commonly well-known mass transit options are Bus rapid transit (BRT), Light Rail Transit (LRT), and Heavy commuter Rail Transit (HRT). Each of these options is then used in different urban scenarios depending on the solution that is sought or the ability to provide them. To qualify as mass transit, the route would need to remain physically fixed and the vehicles would need to travel with fixed frequencies and schedules, enabling them to be reliably used as a regular transport option for commuters. With each transit option, be it LRT, BRT, or HRT, there are a number of considerations and trade-offs that are required to be made when deciding the best solution as each has positive and negative elements that come as part of their implementation and use.

Researchers have found that cities around the world are investing in the introduction and extension of mass transit systems. This recent upsurge of investment is noticeable in traditionally car dependent North American and Australian cities where the introduction of new transit is occurring extensively. Research indicates that these cities are responding to the socio-demographic shifts that have resulted in peak car use, and also in growth in demand for transit (Horwood, 2011; Newman, Kenworthy, & Glazebrook, 2013; Reconnecting America, 2011). The opportunity exists through this period of transit expansion and implementation to reverse and end the cyclic nature of car dependence. The success of transit in achieving the move away from Car Dependency to TOD will be reliant on high quality and well integrated multi-modal networks being delivered alongside land use planning that supports transit use. Funding such significant changes will be a considerable task and barrier for most cities (Mcintosh, Trubka, & Newman, 2014). This thesis will explore how this might be possible through one method; land value uplift and capture.

Land Value Uplift

Land value uplift (LVU) in the context of this research is defined as the land value increase that results from the introduction of transit. To understand the theoretical basis from which the concept and modelling of LVU has been derived, it is worth considering the spatial equilibrium framework developed through the work of Alonso (1964), Muth (1969), and Mills (1972). This body of work looks at the bid-rent attributes of urban economies and has been termed the AMM model; Alonso, Muth, and Mills model (Higgins & Kanaroglou, 2016). Alonso's (1964) bid-rent theory examined the micro-economic trade-offs that occur for households and other locating agents whose willingness to pay for land is based on a trade-off between the area of the parcel of land and accessibility of the land based on its location in relation to the central business district. It holds that on a flat plane in a monocentric model of a city, buyers will pay the most for land located closest to the central business district, and that as land is located further away from this point, the willingness to pay decreases and therefore buyers are able to afford larger parcels of land; this is shown in figure two below. This is then reflected in turn with greater density of development occurring in central areas, with development decreasing in height and coverage as distance from the centre increases. The theory works only in that land is immobile and that the journey to work or to the market place is the most important determining factor in spatial decision making. The validity of this model has declined—even being outdated at the time Alonso produced the theory—however location still holds as an important factor in the value of land. Muth (1969) and Mills (1972) both expanded upon Alonso's theory and a general theoretical basis for spatial equilibrium in urban economies is now understood well and used to this day, even if more polycentric, and alternative models have now been recognised.

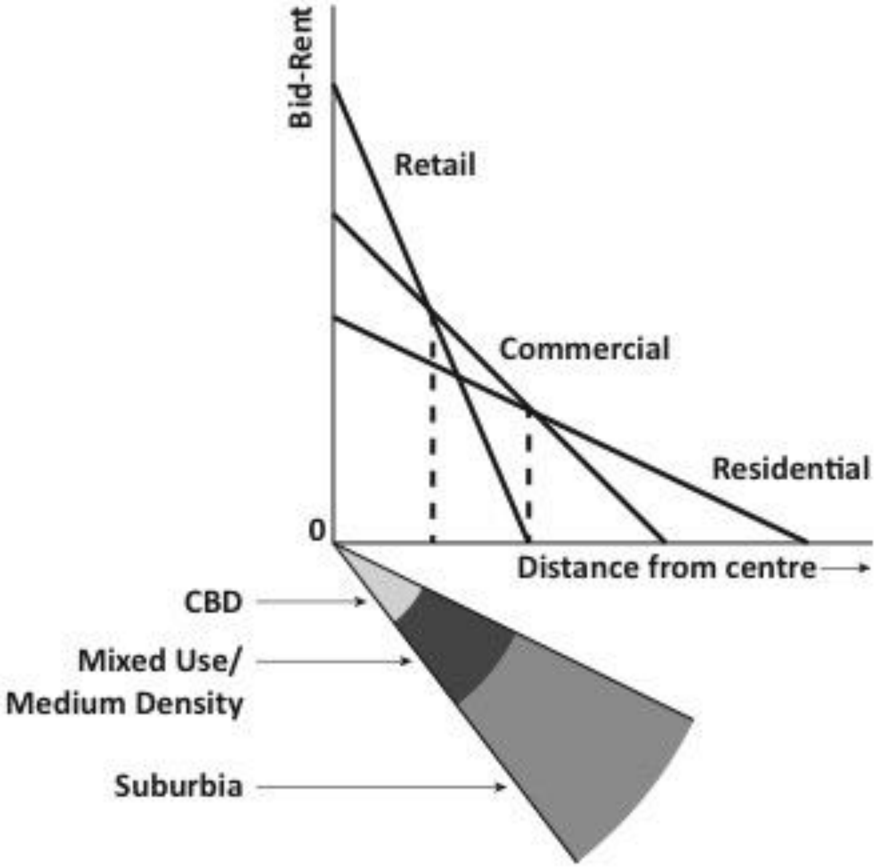

Figure 2 Bid Rent Theory model – Source: Researcher produced inspired by (B. Johnson, 2009)

The AMM model is a hedonic price model, the roots of which was in the work of Court (1939), but was not entirely formalised into a substantive econometric tool as is currently used, until the theoretical work of Rosen (1974). Hedonic models are now commonly used to understand the level of determinacy that any given factor has on a heterogeneous good; a good that remains the same but varies in function, and conversely price depending on its location. 'Immobile land' is one such heterogeneous good that can be priced based on the impacts that factors such as transport accessibility have on it. McIntosh et al., (2013; 2014) have utilised a hedonic model in developing their framework for land value capture upon which this research is based.

Working from this theoretical framework and hedonic econometric tools we can build the basis for understanding transit induced LVU. Research indicates that transport access, in the form of mass transit infrastructure installation and the resultant improvement in accessibility, is monetised into the land values of adjacent properties, operationalising the theoretical framework of the AMM model (Pagliara & Papa, 2011). Significant studies have been conducted on this topic alone and Mohammad et al., (2013) completed a meta-analysis of studies looking at the impacts of rail projects on land and property values. Their analysis found results from 20 different studies with outcomes ranging from decreased land values of -12% through to value uplifts of 120%. Value uplift of land reflects a “willingness to pay” (WTP) of residents and businesses for a reduced cost of distance, both in an economic sense and in real travel costs. Whilst research into the effects on land values from the introduction of mass transit has more commonly found a link with an increase in land values for adjacent and serviced properties, there are still some studies that indicate that this may not be a complete picture (Bowes & Ihlanfeldt, 2001; Higgins & Kanaroglou, 2016; Mohammad et al., 2013).

Land values are determined by a complex array of factors. The work of Bowes and Ihanfeldt (2001) tried to simplify this and demonstrated that two core influences on land value exist; firstly how accessible a piece of land is, and then the productive or developable potential of the land. They describe that other less important, supplementary factors that land values are dependent on include the prevalence of crime in the immediate area, proximity to certain neighbourhood amenities, views and outlook, safety from natural hazards, the impacts of nuisance, and a number of other regional or cultural factors. This is somewhat a ‘cover all bases’ arrangement where neighbourhood amenities and cultural factors could include the likes of segregationist land value differences, like the type seen in ‘Jim Crow America’, where white and black suburbs were established in southern USA. It should be noted that the AMM model only applies within a single spatial area rather than over multiple different land markets. The overall value of a specific land market is determined by the total bid-rent or willingness to pay of all buyers of land in any given market, thus recognising that there may be cases where real estate bubbles could exist if too many buyers were located in a market with limited supply. Each buyer will weigh the price they are willing to pay against these factors and the highest bidder wins and so on until all buyers and all sellers have settled.

Markets, however, are not perfect. One such case being skewed sell prices due to the buyer's development aims for a parcel of land. Commercial land value is very dependent on access and development potential, whereas a number of other supplementary factors become more important in residential land purchase scenarios and developers take this into account. These points were touched on by Higgins and Kanaroglou (2016), who felt that the studies to measure land value uplifts had been too broad and that individual studies could not justifiably be used as a reference for other spatial situations. They argue that there is a lack of consideration made in prior analysis of transit and land value relationships to variables that may have been omitted and unobserved relationships that may exist. When Higgins and Kanaroglou (2016) conducted a meta-analysis they were not even sure that findings supported AMM models, as not all transit projects actually improve accessibility; the foundation of the argument that land value uplift results from transit as it improves access to market/the CBD. They do note, however, that even in cases where patronage is low and accessibility is poor there can still be LVU. There have been other cases where land values increase before transportation improvements have even occurred; as a result of land value speculation by prospective buyers (McDonald & Osuji, 1995). This anticipatory effect may explain scenarios described by Higgins and Kanaroglou. The uncertainty of the exact amount land values will rise creates uncertainty which becomes a political risk and also grounds for disputes to arise both about research on land value uplifts and also for policies that try to utilise LVU for transit implementation.

Land Value Uplift examples

A number of specific studies have examined the relationship between LVU and transit. These studies have been referenced in the modelling for Christchurch, where the uplift experienced in other studies is used to guide the potential uplift that could be experienced from the proposed transit upgrades. For this reason the studies that have been chosen are New Zealand and Australian as the land markets and land use zoning framework are the closest fit to Christchurch, however there are only a couple of these completed to date. The focus is also purely on LRT and HRT rather than BRT or PRT examples, as these have not formed part of the model.

Auckland, New Zealand – Western Rail Line

Grimes and Young (2010) studied the relationship between the upgrades to Auckland's western line urban passenger rail and the subsequent price changes in adjacent land. These upgrades were made to improve and enable a more frequent and reliable service. The line had been in use as a passenger rail for some time however these upgrades included station redevelopments, double tracking, and some urban renewal and associated amenity focused projects. This study, however, was not a hedonic approach but rather utilised a repeat-sales method to estimate the aggregate benefits of the new rail upgrade. Their justification for this methodology was prior research indicating that it is less subject to bias, but is likely to produce similar results to a hedonic model. They do note that there may be possible selection bias in their results, and that their sample size was limited to 6,245 dwellings sold over the period they examined, 2007 – 2009. This approach does though take into account some anticipatory effects that may be occurring.

Their work concluded that proximity to a station results in a land value increase, noting that the increase varied based on distance. LVU of 9.9% were observed on housing located within one kilometre of the New Lynn station cluster. For the other two clusters of stations; group two and three, land value increases of 4.9% and 6.7% were observed respectively. Unlike the group of stations around New Lynn, group one, the other two groups of stations along the line experienced a decrease in land values of properties immediately adjacent to and within close proximity to the station; this was rationalised by the researchers as owing to the now increased train movements nearby causing nuisance. With all three groups of stations, the effect of LVU of nearby properties ceases to exist at approximately eight kilometres from the station. The total estimated LVU was $620 million dollars (*2004*) (Grimes & Young, 2010), with subsequent research suggesting that, despite the LVU being comparable to the implementation costs, further LVU may in fact occur as commuters become more familiar with train travel (Grimes & Young, 2013). Unfortunately further research or even research employing different methodologies has not been undertaken and this remains untested.

Perth, Australia – Mandurah Rail Line

McIntosh et al., (2015) using a hedonic model, studied the Mandurah Rail line upgrade in Perth. The motivation behind this study was to explore if the resultant LVU would be significant enough that the use of tax increment financing would be possible as a means of funding the Rail Line upgrade. The Mandurah line was implemented to help address the ongoing issues resulting from car dependency, a particular problem for Perth, which has largely been planned and built with the car as the sole form of transport. This was part of a broader set of research by McIntosh and colleagues that looked at the possibilities for Perth to utilise a value capture mechanism for transport upgrades and to move away from car dependency (McIntosh et al., 2013; Mcintosh, Newman, Trubka, & Kenworthy, 2013; Mcintosh et al., 2014). From this body of work came a number of potential instruments for value capture, along with the framework that has loosely guided this thesis.

The modelling by the researchers indicated that, based on projected LVU, 43% of the infrastructure cost will be covered by taxes collected by the three levels of government (Mcintosh et al., 2015). Oddly, the hedonic price in this instance is negative. This is largely due to the rail being constructed adjacent to an existing freeway. The negative externalities associated with the freeway were driving down the hedonic price of nearby land. There was, however, an uplift in the hedonic price through to the time of completion as a comparison to the pre-transit base estimate. The measurement of uplift for a 400m catchment was 28%, compared to 13% for an 800m catchment, and 8% for a 1600m catchment. These land value increases, as a result of transit investment, are significant, as are the subsequent impacts on the tax assessment to the three tiers of government. The researchers make a case that a bond could now be used in order to hypothecate the revenue being received into further rail upgrades.

International examples of Land Value Uplift

When exploring the options for the introduction of Value Capture into the Australian transport environment, the Department of Infrastructure and Regional Development’s Bureau of

Infrastructure, Transport and Regional Economics reviewed at a high level what was known about value uplift from transit. They noted a number of averages as shown in Table 1, representing about 100 case studies (Bureau of Infrastructure Transport and Regional Economics, 2015). Whilst some clear averages from different modes are being reported, these numbers have come about from a number of diverse studies. This creates uncertainty about how applicable it is to use other studies in modelling a hedonic price effect of a theoretical transit project on land values. These concerns about the interoperability of prior research results into future forecasted models was addressed specifically by Higgins & Kanaroglou (2016). Many researchers on the topic of land value capture indicate a need for significant restudying and calibration of the value uplift field of work, so as to standardise results and bring the research closer to a comprehensive picture. This complexity makes it difficult to estimate the land value in a model such as that used in this research, thus there is a need to rely on meta-analysis, with an attempt to remove outliers, and skewed results.

Mode	Average value uplift (%)	Range (%)	Number of observations
Heavy Rail	6.9	-42 to +40	18
Light Rail	9.5	-19 to +30	32
BRT	9.7	-5 to +32	14
Note: There were insufficient observations for ferries and road infrastructure.			

Table 1 - Average value uplift per transit mode – Source: Bureau of Infrastructure and Regional Development, 2015.

Deferring back to meta-analysis of global studies was useful to help guide the development of assumptions for this research. This is particularly crucial given the lack of LVU studies completed in Australasia. Three core meta-analysis works exist in LVU research. The first and most cited is Mohammad et al., (2013) which focused on light rail and heavy rail; differentiating heavy rail into metro systems, underground, and commuter rail. The key results of this work indicate that:

- Building/improvement uplifts were less significant than land value uplifts
- Undeveloped land was more likely to rise in value compared with developed land, reflecting a capitalisation into land value development scheme potential

- Commercial land is more sensitive to transit than residential land and land value uplift is highest for office and retail
- Commuter rail results in greater uplift than other modes
- Within 200m of the station the land value uplift is similar to over 800m from the station
- Between 500m and 800m the land value uplift is highest
- There is likely a publication bias with land value uplift research
- The method of land value capture is also likely to have an effect on land value uplift due to perceived economic impacts of different methods regardless of amount of value captured.

The second meta-analysis is that of McIntosh et al., (2014) which was completed as part of their research work on Perth and Australia in general. As their work was not focused on a meta-analysis they did little more than demonstrate the examples, showing how these influenced the model they had developed. Some assessment criteria that they utilised in their hedonic modelling as a result of their meta-analysis were:

- Catchment based methodology, with distances of 400m, 800m, and 1600m representing pedestrian walking times of five, ten and twenty minutes respectively
- Differentiating land uses
- Utilising land valuations only rather than property valuations, which had built form distortions
- Additional controls for Schools, R-codes, proximity to natural amenities, proximity to roads, and the neighbourhood deprivation level.

Utilising these controls within a methodology produces a much clearer result. Below is a simplified Table 2 showing the broad uplift from a variety of projects with some taken from McIntosh (2014).

Mode	Location	Uplift	Study
BRT	Bogota, Colombia	6.8 – 9.3%	(Rodrguez & Mojica, 2009)

BRT	Seoul, South Korea	5 – 10%	(Cervero & Kang, 2011)
BRT	Parramatta, Australia	-10 – 14%	(Mulley, 2013)
LRT	Phoenix, USA	25%	(Golub, Guhathakurta, & Sollapuram, 2012)
LRT	San Diego, USA	3.8 – 17.3%	(Cervero & Duncan, 2002)
HRT	Naples, Italy	10 – 26%	(Pagliara & Papa, 2011)
HRT	London, UK	Up to 30%	(Banister & Thurstain-Goodwin, 2011)

Table 2 - Simplified meta-analysis of similar willingness to pay studies – Researcher produced

The results from the table above have all been produced within a similar theoretical framework, though results vary greatly. One thing that is common is the desire to continue to understand this further so land value capture can occur and these funds can be hypothecated into future developments.

The Unearned Increment and the justification of Land Value Capture

The unearned increment is a description that early economists gave to the increase received by a piece of land as a result of community action. Their proposition was that an individual should only be rewarded in value by personal efforts to create that value and that all other value should be returned to the community that created it. To enable this, Henry George, an early economist, proposed that there should be land taxes in place that fully capture this value so it may be returned to the community, whilst individuals retained any value they personally created. This idea gained steady support and was deemed as an economically efficient, equitable, and sustainable way of raising tax revenues (Smolka, 2015). Unlike income tax, which captures the profits of labour, or sales tax, which reduces consumption, land value tax does not have an economic impact on production, as the taxation of what is produced on the land is not the subject of the tax, but rather the underlying capital value of the land. Often this value is captured privately and wholly by the first on-seller of the land who benefits from either access to the land that the community has created or from development capability of the land that has been allowed or enabled by the community. Land which has no access or land that is unable to be developed is without economic value; only community can create economic value for land (George, 1879). Ad valorem taxes, as described here, have in the most part been completely phased out, aside from some developing economies using them for land re-adjustment purposes (Brown & Smolka, n.d.). Even in the time of George there were critics of Georgist land tax philosophy, despite many economists harbouring sentiment for the economic purity of it. The realities of application would largely lead to its downfall (E. Johnson, 1910). Henry George was not the first thinker on the subject, with both David Ricardo, and John Stuart Mill discussing the topic in their literature. It is from Mill that the argument is summarised here:

> *"Suppose that there is a kind of income which constantly tends to increase, without any exertion or sacrifice on the part of the owner: … In such a case it would be no violation of the principles on which private property is grounded, if the state should appropriate this increase in wealth, or part of it, as it arises. This would not properly be taking anything from anybody; it would merely be applying an accession of wealth, created by circumstances, to the benefit of society, instead of allowing it to become an unearned appendage to the riches of a particular class."*
>
> John Stewart Mill, 1848:Taken from (Walters, 2012)

It is from this ethical standpoint that the capturing of the unearned increment stems, hypothecating the funds back into projects for the benefit of society. Henry George still has a number of loyal followers internationally who promote land value taxation (Lincoln Policy Institute, n.d).

Land Value Capture

LVC as a means of transport financing is becoming increasingly of interest to economists, planners, and other public officials. Agencies are seeing this as a means to pay for needed or wanted infrastructure that would otherwise remain unfunded through existing and available funding mechanisms (The Ministry of Transport, 2014). By implementing a LVC framework and utilising a LVC funding method, financing becomes available beyond sole reliance on traditional funding streams (New Zealand Productivity Commission, 2015).

Common public funding streams for transportation

Urban areas rely on transportation, yet enabling this transportation is a costly endeavour and adding to networks, to extend or improve access, is a difficult task for any level of government. Bonds, loans, or other means of financing require funding to be sourced for projects to go ahead and the tight budgetary constraints that governments are faced with means that projects are subjected to high levels of scrutiny about the cost versus benefits of projects before they can proceed. Often what is not given the same high level of scrutiny is the means of funding government finance, debts, or borrowing for transportation projects. Often project funding streams become a bundled cost alongside the operational expenditure of existing transportation (Langley, 2015b).

Seven key funding methods are used by transportation agencies to finance transportation projects; gas taxes, vehicle taxes and levies, tolls and charges, user fees on public transport, general income and sales taxes, land use levies, and value capture mechanisms (Langley, 2015). As with any tax or charge on a population, a number of measures should be tested to determine if it is the best tax. Henry George discussed this as being tax that is progressive, does not hinder production, encourages best economic use, is difficult to avoid, and has a low economic burden (George, 1879).

The work completed by GVA Grimley (2004) when they developed a methodology for LVC in Scotland evaluated all funding methods against a set of criteria. These were revenue generation capability, revenue allocation, practicality, transparency, transferability, acceptability, policy support, and geographical extent. Each of the current key funding mechanisms is addressed hereafter, and assessed for appropriateness. Whilst this paper argues for the introduction of a form of land value capture in order to fund and therefore finance infrastructure building, below is a look at other means of funding transport operational and financing burdens.

Fuel tax

Fuel tax forms a large part of many countries' budgets for transport financing. In essence, a fuel tax is an amount that is charged on each litre of fuel dispensed. While the collection of such a tax is straightforward, it hurts people who have to consume fuel for production of economic goods, changes and is not predictable based on markets, is decreasing due to more fuel efficient vehicles coming on stream, and also disproportionately affects those with the most significant commutes, which research is starting suggest is largely made up of people from lower socio-economic groups (The Ministry of Transport, 2014).

Levies on vehicles

Vehicle levies are used less extensively than other taxes and are often not targeted at advancing infrastructure. Generally it takes the form of a user tax to recoup damage, however there are often loop holes in the application and it is costly and difficult to administer. Unlike fuel tax this revenue stream is unlikely to decrease in the short or medium term so could be considered a sustainable stream of funding. However, raising the costs of vehicle levies could lead to more evasion and less vehicle ownership. Variations between vehicle classes, reflecting associated costs of road usage, becomes a source of contention for heavy vehicle users who perceive it to be unfair. Heavy vehicles also generally preform their functions within the conduct of economic activity and significant increases in levies may result in a reduction of economic activity (The Ministry of Transport, 2014).

Toll roads and congestion charges

Toll roads and congestion charging are tools through which economic maximisation can be carried out to price demand for road space. Higher charges can be used as a means to control consumption and reduce congestion. The revenue from these tools is then used to improve alternative components of the transport network and also to upgrade and service road assets. The construction of new toll road projects is normally through the use of public private partnerships (Lindsey & de Palma, 2013; The Ministry of Transport, 2014). When congestion charging and toll roads are used effectively they are able to reduce problems such as carbon emissions, while encouraging economic maximisation of road space and transport network capacity. A downside to these systems is that they require significant deployment of policing technology to deter and catch cheats. To facilitate the toll charges in London a significant CCTV camera network had to be installed, creating concerns about the intrusion of privacy of non-car users of public spaces (Litman, 2006).

General taxes and sales tax

General and sales taxation is a way a community can recoup development costs and use this to pay for the infrastructure that the society is benefiting from. However, the tax needs to be implemented in such a way as not to discourage business activity. Whilst sales tax is sustainable, a source of significant revenue, and practical to implement, it lacks transparency of how the money is being utilised for specific transportation purposes, and is considered a very regressive tax. The people that spend the most, end up paying the highest share of tax. This can become an issue in low-income situations, where the marginal tax rate applicable to a household who spends a significant share of their income is higher than a high-income household that spends a smaller portion of their income. In New Zealand this is unsuitable as goods and services tax is raised at a central government level rather than a local government level. It can also be easy to evade if reduced to a regional level of taxation (The Ministry of Transport, 2014).

User fees for public transport

User fees and fare box revenue are often utilised to fund the operation of a public transport system. It is seen as a desirable thing for the users of a system to cover the costs of operation and maintenance, however this is seldom the case and public transport is often subsidised. In New Zealand there is an expectation that at least 50% of the costs of a system is covered by fare box revenue. The remainder is funded from other sources, namely regional government and the National Land Transport fund. As increased fares are likely to reduce patronage, negating the benefits from operating an alternative transportation service, it is unlikely that revenue could be raised in order to create new services, or fund extensions (The Ministry of Transport, 2014).

Land taxes and general rates

These are commonly used, reflecting the sentiment that wider societies should pay for the goods and services they receive. In New Zealand these are administered as rates by the local authority and make up the primary form of revenue for most. These can be broken down into general and targeted rates, and are assessed on the valuation of each property. In most cases they are difficult to avoid and they are reasonably inexpensive to collect. Different property types can be assessed at different rates. Targeted rates can also be used to fund specific services or activities, being able to be ring-fenced to particular spatial areas. The high levels of accountability politicians are subject to due to the representation process at a local level, means rates receive significant scrutiny; which in turn sometimes limits the ability to raise rates for specific projects. Rates and land taxes form the basis of tax increment financing (TIF), where the increase in land values following a project, and the subsequent increase in rating revenue, is hypothecated to pay a particular bond, before becoming part of the general fund (The Ministry of Transport, 2014). This mechanism is the most likely to be employed in a New Zealand scenario despite being uncommon at present.

Value Capture Funding Mechanisms

Value Capture refers to the portion of incremental land value increases that are attributable to the community intervention that is recaptured for public purposes. The most common example of a community intervention is investment in transport infrastructure. This provides value to the property through no action of the owner. This unearned increment, through the application of a value capture method, can be recaptured, in whole or part, for investment in the community.

There are a number of established methods used in this recapture process; land value tax, tax increment financing, special assessments, transport utility fees, negotiated extractions, development impact fees, co-development, and air rights. Whilst some of these are used already in general transport financing, the linking of these to land values is less common in application. Each of these financing methods also has variations in the equity, sustainability, and feasibility of application (Langley, 2015b).

Land Value Tax

A value capture approach using a land tax captures the increase in the value of land due to the improved accessibility. The approach can be utilised as a one off cost at a sale or an ongoing tax assessment on a land’s increased value. This tax is levied purely on the non-user beneficiaries of a project whose land now benefits from enhancements in the accessibility. Land taxes are conceptually well supported and many studies have been completed arguing for their implementation. However, there remain few examples of this in practice and multiple scenarios where the tax has been repealed over time. Historically, this type of taxation has been referred to as betterment tax. These were very popular and common across the industrialising world during Victorian times when taxation would be applied to properties when they became connected to infrastructure services or when transition was enabled from rural to urban uses and therefore development was able to be intensified. Rural to urban conversions through zoning are still where the majority of betterment taxes are applied. The lack of use of this taxation of the land value gains from transport improvements, and also the reason many betterment taxes have been repealed derives from the difficulty in their administration(GVA Grimley, 2004; Kemp et al., 2013; The Ministry of Transport, 2014).

Land value taxation requires very precise measurement of land valuations. In many countries, the access to data for land valuation is limited due to incomplete recording of sales and land data. In some instances, public access to this data is prohibited. Due to its use in real estate sales and for economic trends and modelling, land value data is a lucrative money earner, which has incentivised privatisation. These limitations make the valuation of land both prior to and post improvement difficult and costly to assess, and is further exacerbated by the challenge of isolating land value from the total improved capital value of the land unit (Ardila-Gomez & Ortegon-Sanchez, 2016).

Land taxes do have multiple benefits and this is why they stay popular in theoretical works. Well placed efficient transportation leads to large value increases in nearby land, resulting in windfall gains by owners who realise these gains. As primary beneficiaries in an egalitarian society it is appropriate to tax them as directly as possible: Henry George's least bad tax (Ardila-Gomez & Ortegon-Sanchez, 2016; Bureau of Infrastructure Transport and Regional Economics, 2015; GVA Grimley, 2004).

Tax Increment Financing

Commonly used in scenarios where public investment is needed to spur on private development, tax increment financing works on the assumption that new infrastructure will result in increased property values and subsequent higher tax revenue. The difference between the original tax revenue and the increased revenue following improvement is the increment used for financing. Agencies calculate this initially and raise loans against the enhanced future tax base. Unlike land value tax where some of the gain is taxed as a hypothecated amount, only the increased tax due as a result of high property prices is used in tax increment financing(Kemp et al., 2013). This results in the relevant assessed land owners keeping the additional value gains. The increased taxation revenues are only hypothecated into the transport budget until the funding is repaid, and then the tax increment becomes part of the general fund. Use of tax increment financing is often a way for local areas to match higher levels of government funding to bring forward infrastructure projects. It also provides good political arguments for transit financing, by linking the value gain and ability to achieve extra finance without applying extra burden on land owners, despite the land owners being the primary beneficiaries of projects through the increased land values (The Ministry of Transport, 2014; Zhirong Jerry Zhao, Das, & Larson, 2011).

Special Assessments

Special assessment districts and business improvement districts are areas where an above and beyond property tax or sales tax is leveraged for a set timeframe in a specific area in order to finance debt for the improvement to that area. They are a popular instrument in main street improvements, urban renewal works, or rural to urban infrastructure provision. Communities or areas within the district negotiate a levy or taxation over and above the municipal appraisal and this additional collection is ring fenced into financing the improvement project. This is a way in which the value gains that are accrued from a project can be captured in the financing arrangement. Unlike a tax, they are a negotiated instrument and often assessed much lower and less significantly than the value gains from the projects. Seldom do they cover the total value of projects to which they are contributing (Kemp et al., 2013).

Special assessments are often subject to legal action following their implementation, making their use challenging. Given the timeframes of loans, this can become problematic and costs can shift back to the utility provider. Special assessments are also regressive and smaller land owners, or those not sharing in such high value gains can experience lower value gain to tax ratios than wealthier and greater value gaining land owners. Despite these issues they are increasingly being used in urban scenarios (Z. J. Zhao & Larson, 2011).

Transport Utility Levies

Transport utility levies are implemented on the basis that transport is like any other utility provided and is therefore taxable as such. Landowners or tenants are charged a fee based on the assessment of generated transport demand to a parcel of land. This results in high users paying the largest levies due to the largest number of trips they generate. Charging a transport utility levy recognises the value that transport provision provides for a business or premises and allocates a charge on this. These charges can then be used to fund network based transport improvements. The issue with transport utility levies is they do not always completely recognise the link between transport and land values, particularly in instances where they are levied against two similar business operations in vastly different locations within the urban environment (Ardila-Gomez & Ortegon-Sanchez, 2016; The Ministry of Transport, 2014). They also do not encourage maximum utilisation as there is no fee chargeable on vacant land, thus reducing the costs of land speculation or 'land banking' (Lari et al., 2009).

Negotiated extractions

Like development impact fees, negotiated extractions occur in the development phase of land value uplift. A portion of land, development, or cash in lieu is negotiated in exchange for the provision of infrastructure or access. The developer, by negotiating, is recognising the value the infrastructure is providing, enabling the development to go ahead and be successful. Rather than be applied on a broad municipal basis, or as a set fee, extractions are negotiated on a site by site basis. As a significant share of the value uplift occurs on the land value rather than on capital improved value, negotiated development extractions risk hindering or dis-incentivising development to occur on greenfield sites. To prevent this from occurring local jurisdictions are encouraged to apply the nexus principle in that the extraction is reasonable, and there is a clear link to the required infrastructure contribution needed to promote development. In areas of regeneration they can be an effective means to provide new facilities that would promote development (Lari et al., 2009).

Development impact fees

Imposed at the development phase of value uplift, development impact fees are an application of a fee on development at a fixed rate to provide for infrastructure. They recognise that existing infrastructure is provided by and for the existing community and that new development should pay for new infrastructure provision. This can be utilised in situations to fund capital growth in addition to funding future operational and maintenance expenditures. It can be difficult to establish the exact costs of the impact of new development and, as a result, development impact fees can be a cumbersome calculative process (Lari et al., 2009). In New Zealand these are known as development contributions (The Ministry of Transport, 2014). Development impact fees can be a method to encourage more compact development through differential charging; a situation occurring in Christchurch with the development contributions rebate.

Co-development

The most hands-off of the land value capture approaches, co-development leaves the development and control of infrastructure building to private parties. Payments for development can take a number of forms, the most common being that the government gives the right to develop land in conjunction with the development of infrastructure. Projects using co-development are able to integrate infrastructure and generally supply development that is in-line with market objectives. The downside to this method is the high associated setup costs, higher risk of failure, and public perception risk with regard to private sector benefiting from public goods (The Ministry of Transport, 2014).

Land Value Capture – International Case Studies

Case Study 1: Linha Verde, Curitiba, Brazil – Highway Conversion to BRT

Project context:

Authority: Urbanização de Curitiba (URBS, Urbanization of Curitiba)
Area: Curitiba, State of Paraná, Brazil
Project: 9.4km Freeway to BRT conversion, Stage 1
Mode: Bus (Rapid transit development)
Cost: $60 million USD (2009)
Value Capture: Certificates of Additional Development Potential

Overview

The 9.4km first stage of Curitiba's green line is the start of an 18km BRT axis connecting 23 districts of the metropolitan region and over 280,000 residents. Included in this development is a 20,000m^2 linear park, 6km of cycleway, and a redeveloped road system (Lindau, Hidalgo, & Facchini, 2010). The area where the line is being developed was a former roadway, wide enough to accommodate 8-10 lanes of traffic (De Almeida, 2009). Worldwide, Curitiba's BRT system is held up as a model example of an effective and cost efficient alternative to a subway system. It currently operates free of any subsidy. The network was initially developed in the 1970s and is the backbone of Curitiba's transportation system, carrying the majority of daily commuters. Low fares mean citizens use less than 10% of their income on travel (Goodman, Laube, & Schwenk, 2001)

Impacts of development

The green line is expected to have a capacity of 32,000 passenger journeys per day. Since the line was developed, nearby land has seen substantial value increases along the corridor. This increase in land value helped promote the development of multiple low density industrial sites, described by commentators as an urban renovation (Lindau et al., 2010).

The network has recently transitioned to operating solely bio-fuelled buses, resulting in 30% less carbon emissions and 70% less smoke; reducing many negative impacts of the bus system (Lindau et al., 2010).

Value capture mechanism

Funding for the development of the line was expected to come from the sale of additional development rights. The city of Curitiba closely controls land use and allows for additional development only through the purchase of development certificates. These CEPACs (certificate of additional development potential) are auctioned off as a tradable credit within specified areas along the route (Neto & Moreira, 2012).

Lessons learned

The auctions for the CEPACs occurred at a time when the property market was severely depressed. Yields were only slightly over minimum prices and less than 60% of the anticipated funds were raised (Smolka, 2015). Since this time, property has recovered strongly and these CEPACs have increased in value meaning this project missed out on value gains that could have gone into the development of the line.

Case Study 2: Kwun Tong Line Extension, Hong Kong

Project context:

Authority: MTR Corporation Limited
Area: Kowloon City District, Hong Kong, SAR, China
Project: 2.6km Extension of the Existing Kwun Tong Line
Mode: Underground Rail
Cost: $5.3 billion HKD (2009)
Value Capture: Rail plus property

Overview

The Kwun Tong Line extension is adding an additional 2.6km of underground rail line, connecting the existing line from Yau Ma Tei station to the newly developed Whampoa station. The Ho Man Tin interchange will also be developed and improve connections to the central island. This development will offer reliable, convenient, and fast transportation to these areas currently served predominantly by motor vehicles (MTR Corporation, n.d.). Whilst only a short section of track, it has substantial impacts on travel times, from 25mins by car to 5mins on the proposed line. 146,000 residents will be serviced by the line once complete (Transport and Housing Bureau, 2014).

Impacts of development

Significant travel time reduction and the anticipated mode shift from vehicles to train that will happen once the development is complete gives the line a very high economic rate of return (8% annually). The high economic gains come from direct travel time reductions for users of this service, as well as road network capacity improvement resulting from the predicted reduction of cars originating from a central and strategic location, increasing flow rates across the transport network (MTR Corporation, 2008).

Value capture mechanism

Despite the high economic rate of return, a poor financial rate of return leaves a funding gap of $3.5 billion HK (2009). To plug this funding gap and enable the development, the Hong Kong government gave special concession to the MTR Corporation to develop the Ex-Valley Road Estate Site near the proposed Ho Man Tin interchange. A five tower, 1800 apartment complex is proposed for the site. Developing this site leverages the increased value of this real estate and its proximity to transport, enabling the use of profits for rail development; a model the MTR is very experienced in using (MTR Corporation, 2011).

Lessons learned

Despite some government owned shares, the MTR is a listed company and, as such, is profit motivated. This motivation means it will seek good financial rate of returns. In this case the government was criticized by some for gifting the MTR a very valuable strategic site that had been earmarked for social housing, with suggestions the profit that the MTR will receive from the development of the site is disproportionate to the funding required by the MTR to build the line (Yuanhua, 2012).

Case Study 3: Gold Coast Rapid Transit: Light Rail

Project context:

Authority: Gold Coast City Council
Area: Gold Coast City, QLD, Australia
Project: 13km 16 Station light rail
Mode: Light Rail, dedicated corridor
Cost: $949 million AUS (2011)
Value Capture: Global metropolitan wide levy

Overview

The Gold Coast rapid transit is a 13km light rail with 16 stations and supporting east/west feeder buses. This is the initial stage of a planned eventual 40 km network of rail which has been marked for completion over the next 25 years (Railway-Technology, n.d.). Once complete, the entire network will service just short of one million residents, reach most of the business activity centres, and link tourist hot spots (Gold Coast City Council, 2013). The light rail will be a city shaping project, and is seen as key to meet and support the growth demands in one of Australia's fastest growing areas (Mepham & Grennan, 2012).

Impacts of development

The stage 1 route targeted key institutions including Griffith University, the University Hospital, 20% of regional employment, and several tourist centres. The light rail opened in July 2014 and has experienced better than expected uptake, with passenger numbers continuing to grow. This success has been attributed to: the speed, due to the dedicated light rail corridor; attractive and well located stations; and comfortable carriages, with the capacity to carry surfboards. Enabling the trains to carry surfboards deterred residents from vehicle ownership and maximised the project benefits by have people use the train for both commuting and recreation; surfing is the most popular recreational activity in the region (Stay & Griffin, 2015).

Value capture mechanism

The project is a public private partnership, with a build and operate contract being awarded to GoldLinQ, a consortium. Funding for the project was provided by three levels of government, the Federal government $365m, the QLD state $464m, and the Gold Coast council $120; the latter's commitment being partly funded by a metropolitan-wide levy. This levy is an attempt to capture the private benefits of the project and use these for financing; a form of value capture (Gold Coast City Council, n.d.).

Lessons learned

The levy was deeply politicised and was not well explained through the consultation and development process. The levy is also not ring-fenced and there is no commitment in using it to fund future stages of light rail (Mcintosh, 2012). The levy's link to actual increases in property value is poor, and with low buy-in for the levy, future transit development in the region has been jeopardised and the full benefits of the light rail may not be realised.

Case Study 4: NoMA Gallaudet University Infill Station development

Project context:

Authority: Washington Metropolitan Area Transit Authority (WMATA)
Area: District of Columbia, Washington D.C., USA
Project: Area redevelopment & Infill station development
Mode: Rail (Existing network/New station)
Cost: $103.7 million USD (2004)
Value Capture: Active part contribution, special taxation district

Overview

The NoMA – Gallaudet University Station was constructed by the Washington Metro Authority as an infill station on their existing Metrorail system. The system was developed in the 1960s-70s and this station is the first infill station built since. This station was also the first time WMATA used a mix of public and private funds to contribute to the costs of development (Schlickman, Snow, Smith, Zelalem, & Bothen, 2015).

Development of an infill station in this area had often been disregarded due to the area's historic underdevelopment and high car ownership. This changed in 1998, when consultation was initiated to evaluate station suitability and demand by the community, which cumulated in a station being built, opening in 2004 (WMATA, 2010).

Impacts of development

The station was a success for reasons including urban regeneration, increasing the local tax base, greater community led decision-making, increasing network ridership and revenues, reducing car ownership, and increasing the value of WMATA assets nearby (MacCleery & Tarr, 2012). Prior to the station, the area was well connected by roads, but congestion and a lack of transport alternatives was stymieing development. By improving transport access, the station was able to unlock development potential, with 3 billion dollars of construction occurring since the station was built (Parsons Brinckerhoff Consultants, 2011). Land values have also increased 6.8 – 9.4% over and above regional increase (AECOM & Smart Growth America, 2011).

Value capture mechanism

With community support, the Washington Metro authority created a special tax assessment district. Owners agreed on an 800m catchment for 30 years to service $25 million in bonds. Further to the contribution of the community, the federal government gave $25 million with a further $53.7 million from the District of Columbia. This ability to utilise private funds enabled the development to go ahead (Mathur, 2011).

Lessons learned

The key learnings came out the community engagement processes. Initial feasibility studies were useful in generating buy-in from the communities who would later form crucial partners in enabling development to occur. To get political support for the special tax district to go ahead, the authority found that they needed to go beyond consultation alone and have full inclusionary planning (WMATA, 2010).

Case Study 5: London Crossrail

Project context:

Authority: Greater London Authority
Area: London, East West through the City
Project: 100km rail project, 42km of tunnels, 40 stations
Mode: High Frequency/Capacity Rail
Cost: £14.8 billion GBP (2009)
Value Capture: Business Sales Tax and property development

Overview

Crossrail is Europe's largest construction project, started in 2009 and expected to be completed in 2017. The route is a dual track 100km line, for which 42km of tunnelling is being completed. There will be 40 Crossrail stations, including 10 new stations that are being constructed as part of the project. The route goes from Reading and Heathrow in the West through to Shenfield and Abbey in the East. On route it passes through London's key business, employment, and entertainment districts, including Heathrow, the West End, the City, and Docklands. Once complete, it will enable an additional 1.5 million residents to be within 45 minutes travel time of central London, as well as providing significant service improvements to an additional 750,000 exiting service users. Annual travel on Crossrail is expected to exceed 200 mllion passenger journeys (Crossrail, 2015a).

Impacts of development

Given the size of the project, coupled with the additional 10% capacity increase on the public transport network, it is expected to generate significant economic gains. Early estimation has suggested it is in the region of nearly £50 billion, generated through travel time savings, increased economic activity, gains in land values, decreases in greenhouse gas emissions, innovation in rail sector development, and greater access to marketplaces both domestically and internationally (Colin Buchanan and Partners Ltd., 2007). The project also employs 8,700 people. The expanded capacity in the network is also enabling substantial increases in the housing stock nearby (City Of London Corporation, 2015).

Value capture mechanism

The Greater London authority is seeking to capture part of the economic gains realised to help fund development. Likewise, the project also seeks to benefit from the large increases in property value caused by Crossrail. It has twelve major developments along the route with an expected income of £500 million (Crossrail, 2015b). Businesses in the London area have also had a number of levy and tax mechanisms introduced and this will result in the direct business contribution to the project totalling more than £4.1 billion. Additionally, a few large institutional organisations and businesses will directly contribute almost £1 billion for investments in station and network infrastructure. The total funding raised through direct value capture totals more than £5.6 billion(Greater London Authority, 2009). Significant attention will be paid to the success of Crossrail.

Case Study 6: Ørestad Development Scheme, Copenhagen Metro, Denmark

Project context:

Authority: Ørestad Development Corporation
Area: Copenhagen, Denmark
Project: 21km metro link to central Copenhagen
Mode: Light Metro Line
Cost: €1.6 billion (2004)
Value Capture: Direct payment, Land Sales, and Real Estate Taxes

Overview

In 1992, the City of Copenhagen and Ministry of Commerce formed the Ørestad Development Corporation (ODC). The ODC was empowered to develop 310ha of vacant land within 10 km of Copenhagen city centre. The area is very narrow, and forms part of the link to Malmo, Sweden. A core part of this land development was the construction of a 3 stage mini metro system, 21 km in length, with 22 stations (Stevens & Schieb, 2007). The ODC was also responsible for the construction of all public spaces.

Impacts of development

Regulations enabled up to 3.1 million square metres of floor space to be constructed. The mix of development was planned as: 60% commercial, 20% residential, and 20% dedicated to cultural facilities, retail, and educational institutions (Stevens & Schieb, 2007). To date, just over half of all available land for sale has been purchased. Initial sale of land was strong, but building development has been slow (Ten group, 2010). Some of the early buildings have been heavily criticised and still only 8,000 people live there and relatively few jobs have eventuated. Over time, it is expected that construction will increase and the number of residents should rise to 20,000, and the number of jobs to 80,000 (By & Havn, n.d.).

Value capture mechanism

To fund the construction of the public spaces and the metro, the ODC used government backed loans. These debts were repaid through the money raised from the sale of land and subsequent development rights. These sales leveraged the value gain that occurred through the development process, and the rise in value that the metro connection to central Copenhagen created. 55% of the initial investment of land came from the city of Copenhagen, with the remaining 45% from the state of Denmark. No further public funds were used aside from sovereign backing of debts.

Lessons learned

Several slowdowns in the property market affected the project, with the Global Financial Crisis of 2007 having a severe impact. The crisis that ensued resulted in land devaluation of 30%, slow land sales for four years, and the disestablishment of the ODC. The remaining land, debt, and assets were transferred into a new agency more able to negotiate additional lending. The payback period for debt changed from a planned 15 years, to an expected 76 years. The key failing was a lack of good risk management, with poor foresight of market realities(Flyvbjerg, 2007; Majoor, 2005).

Case Study 7: MAX: Red Line Airport Light Rail, Portland, Oregon, USA.

Project context:

Authority: (TriMet) / City of Portland
Area: Portland International Airport, Oregon, USA
Project: 8.9Km train to plane light rail link
Mode: Light Rail Transit
Cost: $125.8 million USD (2001)
Value Capture: Joint Development, Tax Increment Financing (TIF)

Overview

The Portland MAX: Red line light rail extension is an 8.9km link that connects the MAX transit system to the Portland international airport. The development included four new stations, a large park and ride, and the private partner was given 120 acres of land, which was zoned as mixed use. The light rail had been designed many years earlier with the redevelopment of the Interstate 205. This meant the project had an already dedicated right of way set aside. However, the light rail was delivered 10 years prior to plan due to the availability of private equity. It was the first light rail project in the USA to receive no federal funding, state general funds, or tax increases. Annual ridership exceeds one million passengers (TriMet, 2012).

Impacts of development

Originally, the private partner, Bechtel, had envisioned using development rights they were allocated to create a commercial centre and a hospitality district both with dense levels of employment. The 9/11, 2001 events meant the economy and airport travel cooled, forcing Bechtel to sell their interests to new developers, Trammel Crow. They repositioned the development as a retail centre with a few flagship big box retailers. This ultimately reduced the demand on the light rail services as the anticipated commuters didn't eventuate. Port of Portland is, however, still developing commercial land nearby the light rail as demand facilitates (Gosling & Freeman, 2012).

Value capture mechanism

The MAX: Red Line was funded through a unique mix of value capture mechanisms. Firstly, tax increment financing through the Airport Way Urban Renewal area, which used some debt funds to support the light rail project. One third of the development cost was contributed through the commercial arrangement with Bechtel, in exchange for the development rights to a 120 acre land parcel along the light rail route. The remainder came via an arrival levy charged on each passenger coming into Portland International Airport.

Lessons learned

Despite the success of using value capture mechanisms to fund the light rail, the complex arrangements meant substantial approvals, negotiations, and time. Cascade station also yielded suboptimal development due to forces of market pressure and the commercial realities Bechtel faced (Gosling & Freeman, 2012).

Key Lessons Learned from International Experiences

The key conclusion that can be drawn through the review of international experiences with implementation of value capture strategies is that, in practice, many elements need to be right in order to implement a successful strategy. The international examples show that some failures can jeopardise entire projects, and even small errors over long periods of time can substantially decrease the value that is returned to the funding pool, greatly impacting the long term outcomes of a project. For projects to be successful there appear to be six key factors that contribute to positive results: localised strategies that take into account specific spatial and local contexts, a clear link in value capture and value being created, the ring fencing of value captured funds for explicit and specific purposes, an adaptive strategy that responds to market situations, correctly setting the amount of value to be captured, and sound project risk management and leadership.

I - Localised strategies that take into account specific spatial and local contexts

In each jurisdiction, there are differing legislative environments that can enable or restrict certain value capture strategies and mechanisms. Some liberal planning environments enable transportation development to occur concurrently, as is the case with Hong Kong and Curitiba. For other locations, the planning environment is restrictive and rules enable only selected practises to take place, as was the case with Portland where, as a result, innovative solutions were required. Reviewing the legislative environment, assessing the limitations and opportunities it poses is a key first step, enabling a guide for future work to take place.

Following this, further understanding the proposed implementation area's willingness to pay for transportation will provide clues of the demand for travel alternatives. In some places, transportation usage and reliance is much higher than in others, having a distinct impact on the value created by projects, and the potential amount able to be captured.

Existing development in an area will determine success, as value can really only be meaningfully created in situations where there is additional development capacity. This was the case in NoMA Gaudete station development, where congestion and the lack of transport system capacity had limited development opportunity. In Ørestad the opposite was true; excessive development capacity subdued the land price and the value creation opportunities. By taking these exploratory steps the right strategy can be chosen that best fits the local and spatial context.

II - A clear link in value capture and value being created

In a situation where a value capture strategy is being enacted, authorising agencies need to ensure that the affected area of implementation is clearly experiencing a value gain as a result of the project. In situations where the market or developers fail to see the cost of a value capture approach being absorbed by the value gain being created in an area, the perspectives towards the use of value capture will be negative. This commonly occurs in situations where the value capture method being used is applied over a spatial area that is too broad, resulting in properties at the periphery experiencing little to no value gain but having to pay taxes or levies regardless. When such instances occur, the negative perspectives of these property owners can be toxic for the use of value capture as a funding strategy and risk jeopardising future implementation of value capture tools and consequently future projects.

In the case of the Gold Coast and in London, both adopted jurisdiction-wide taxation, imposed even in the areas not adjacent or proximate to transportation projects. These areas that are taxed, but not adjacent to transportation improvements are unlikely to see significant changes in land values or development increasing. In these two cities there has been significant negative press about the taxation and equity of its application. This becomes a risk when being implemented by authorities governed by elected officials as short political cycles can result in projects being cancelled, funding being scaled back, and even politicians being elected due to their opposition stance with regard to value capture approaches.

By comparison, in the case of NoMA – Gallaudet University infill station, a strong business influence lobbied hard in initial negotiations and succeeded in minimising the value that was captured, leaving the Washington Metro Area Transport Authority with a much larger share of costs, and land owners with greater gain from the value created by the station. The additional value that would have been captured, had the WMATA been stronger in negotiations, could have been used to reduce the share of the project costs incurred by the agency, pay back debt faster, or even used to fund future transportation improvements.

III - The ring fencing of value captured funds for specific purposes

When value capture tools are used, the funds raised should be ring-fenced and used for specific purposes and projects rather than form part of a general budget. The best example of funds not being ring fenced is the Gold Coast metro. In this case a transportation levy was charged on all properties in the district, and rather than just being used for transportation and ring fencing it for this purpose, the money has been used as part of the overall regional authority's budget. This has created an environment where it is not clear whether the levy is being fully used for transportation or not, giving voice to critics of high taxation to speak out in opposition to the levy.

As the Gold Coast light rail is only the first stage of a much larger regional transportation improvement project, significant funding is required in the future. Opponents to light rail have been calling to axe the levy, which would render the authority unlikely to be able to source funding for the wider project. If the levy had been initially ring fenced and clear funding pools allowed to develop, future stages may have received wider support, and had access to funding pools they could draw from. The discussion for the future of the Gold Coast light rail has now revolved around funding. The debate and growing opposition now jeopardises future development from occurring and, ultimately, the success of wider transportation and development goals.

As a comparison to the Gold Coast, Hong Kong has managed to create one of the best metro systems in the world, through the use of the MTA, a completely independent entity with its property plus rail development method. Excess value captured from each project is used to help fund future projects and thus enhance the entire network's efficiency and capabilities, further encouraging the use of the metro.

IV - An adaptive strategy that responds to market situations

Value capture strategies need to be implemented with the market in mind. Not taking into account the context of a particular market situation when implementing a value capture strategy can create significant risk for a project success or can mean otherwise significant value gains will be uncaptured. In Curitiba the CEPACs were sold at auction during a period where the property market was declining. The auctions failed to generate significant interest from developers who were struggling to sell existing developments and, as such, the CEPAC sale prices were low and in some cases barely met the legal minimum reserve price. When the property market recovered a short time after the auctions and development rebounded rapidly, the authority was left having already sold a significant share of the total available development rights, and with it the chance for much larger value gains. Given the deflated prices of the CEPACs sold at auction, many private resales of the development rights occurred, and initial buyers earned large profits.

In the Ørestad case, the scheme began at a time when land price and demand was at a very high point historically. Shortly after completion of the Ørestad metro, the market retracted and demand for new development land subsidised. Prices stabilised downwards from their historic high and the ODC failed to sell almost any land for four years due to the high prices being asked. The agency, faced with debt repayments to service, had to severely compromise on the permitted development outcomes, leading to some poor and heavily criticised development. It was only once a devaluation of land asking prices by 30% occurred that sales began again and development reignited. The debt in the interim period had ballooned and success of the scheme has now become dependent on utilising equity in other land development schemes to enable continued borrowing. Whilst market predictions are difficult, implementation strategies need to be adaptive and responsive so extreme high and low land values can be factored into the value capture approach and not create risk for schemes.

V - Setting the amount and timing of value capture

Capturing the value that is created by a transportation project or improvement is a balance between enabling development and discouraging it. To achieve this balance, value capture strategies need to be designed to capture the right amount of value at the right time. This process can be very difficult to get right and is why many agencies choose broader rather than more specific methods. This relates back to method selection and designing strategies that fit within a local context.

To help get this right there needs to be a good understanding that different methods will capture value at different stages of the development cycle. Some capture the value through the sale of land, through business taxes following development completion, through property taxes, or development costs being imposed on additional development rights. Depending on whom and when the value capture is applied, a risk exists in that too much value will be captured and that development will be discourage or suppressed, eroding the value created in the first place. Conversely, capturing the value too late in the development cycle imposes costs on parties that have not been party to the value realisation and, as such, become an additional cost to the end user, increasing the cost of development. Accurate modelling is needed to help mitigate the risks, but it is very difficult to fully control for, and a process for ongoing review needs to be developed to support value capture approaches and to ensure the right value is being captured at the right time.

VI - Sound project risk management and leadership

With the added complexities in adopting a value capture strategy as part of funding a transportation project, competent project and risk management is essential. The poorest example that has been studied as part of these international examples is Ørestad. Poor risk management and lacking response to issues undermined the project and a complete restructuring was required of the agency responsible to remedy these failures. The best example, perhaps owing to the massive size and overwhelming complexity is the London Crossrail project. Crossrail is the largest infrastructure project in Europe, and constant review and management has kept the project on task and also made sure the value capture strategy is the right fit for the project. With any large project, controlling risk through all stages is important but with value capture approaches there is also increased need to manage risk prior to and post implementation to ensure the strategy corresponds into development and value being created adjacent to transportation projects. To achieve this, a mix of integrated planning, modelling, risk management, and economic forecasting is required. The more comprehensive the mandate is of the authority managing a project, the greater the chance for success. When different organisations are responsible for different components of implementation, strategies and projects can quickly fall apart.

Considerations for New Zealand

These case studies provide important considerations for local implementation. New Zealand planning authorities need to understand how different economic and funding instruments could be used to help fund future transportation projects. The current legislative context in New Zealand does not allow for truly pure value capture strategies to be implemented and local governments must rely on general rates, and government on income and sales taxes for the funding of transportation projects (The Ministry of Transport, 2014). There has been recent interest, however, in exploring options looking at how New Zealand might be able to diversify funding sources to enable larger ticket transportation projects to proceed. At present there are few examples of different funding models being used and if alternatives are sought it will be important to learn from the experience of international examples.

Taking into account the six discussed lessons above, the task to develop a coherent strategy is neither small nor simple. Some early points to consider as we look for options would be:

Localised strategies that take into account specific spatial and local contexts

- How does regional and urban New Zealand vary in the way methods would work?
- Does inflated housing pressure in urban centres preclude suitability for certain methods?
- What influence do high levels of speculative land investment have on value gain and realisation potential in New Zealand?
- Following transportation improvements, do the Resource Management Act and district planning regime in New Zealand provide enough support for development to occur, creating sufficient value gains for value capture to occur?

A clear link in value capture and value being created

- Does New Zealand have the legislative appetite to develop a framework that would enable targeted rates?
- Is the current access to the required data such as land price, sales data, and well-structured geospatial systems in place to enable a fair test of this?
- Would the models used to assess this value gain stand legal test if they were to undergo legal review in the courts system?

The ring fencing of value captured funds for explicit and specific purposes

- As most New Zealand taxation and levies are used as part of general budgets, is there sufficient maturity and capability in treasury and local government accounting to enable this to occur?
- Would the pooling of funds be politically able to occur when other government spending such as social welfare or environmental protection remain low or poorly funded? Could the public culturally be able to differentiate the funding sources from the spending?
- Is the Land value capture an adaptive strategy that responds to market situations?

- With the inflated property price in Auckland, is implementation of a value capture method even possible and would transportation improvements increase land values sufficiently to provide a gain able to be partially captured?

Correctly setting the amount of value to be captured

- As discussed prior, does the limited availability of sales data due to privatisation and a poor geospatial data framework create a barrier to being able to set the value capture amount correctly?
- As the public consultation framework in New Zealand creates anticipatory value gains, does this pose a barrier to suitability of certain value capture methods?

Sound project risk management and leadership

- Does New Zealand have the required project management and leadership capabilities to enable value capture to form part of projects or is there a need to build this capacity?

New Zealand is likely to continue with a programme focused on improving the transportation access throughout its urban and regional areas as a tool to support growth and achieve economic prosperity. However, we also need to find ways to bridge funding gaps to enable these projects to go ahead. Value capture methods are worth exploring as a number of opportunities are likely to exist for implementation but, as this research indicates, there is a need to develop localised strategies and approaches that are the right fit. New Zealand will need further, but prompt, research to help guide and enable funding sources for the next generation of transportation projects throughout the country.

A Review of Land Value Capture Methods

This section is a simplified review of the available value capture tools evaluated within a framework of appropriateness to a New Zealand context. Frameworks for developing a LVC strategy are proposed by a number of authors each emphasising the benefit in following evaluation criteria to decide on the most appropriate tools for use in a LVC scenario (Iacono, Levinson, & Zhao, 2010; Langley, 2015b; McIntosh et al., 2013). The criteria are evaluated on equity and efficiency, making sure the tool will achieve targeted development objects, low administration burden, and ensuring that there is a clear link/nexus between the taxation and the value that is created. The character of the revenue generated is evaluated – is it sustainable and is it predictable? The last test is on the acceptability, for the public, politically, and by the government.

Table 3, below, showcases this evaluation. When each tax type is deemed to pass the test, a dot is recorded. The information to complete this summary has been obtained from the following cited research (Act, 2014; Kemp et al., 2013; Langley, 2015b; LGNZ, 2015; SGS Economics & Planning, 2007; The Ministry of Transport, 2014).

	Equitable and Efficient			Revenue Character		Acceptability		
	Achievable objectives	Low administration	Clear link between value and tax	Sustainable	Predictable	Public	Politically	Government
Sales Tax	•			•	•	•	•	
Stamp Duty	•	•			•			
Land Tax	•	•	•	•	•	•	•	
Negotiated planning agreement	•		•		•	•	•	•
Co-Development	•		•			•	•	•
Betterment taxes	•	•	•	•	•	•	•	
Air rights	•		•		•	•	•	•
Property Development	•		•		•	•	•	•
Transport Levy	•		•	•	•	•	•	?
Density bonuses			•	•	•		•	•

Table 3: Evaluation of Land Value Capture Tools - against framework for a New Zealand Scenario - Created by researcher

As shown above through the visualisation of the research there are few land value capture mechanisms that are available for use in New Zealand by local councils. The central government has greater liberty with funding arrangements for transportation and taxation but has seldom shown interest in moving away from broad based taxation through goods and services or income taxes. Kemp et al., (2013) completed a review of the available mechanisms in New Zealand, and the legislative frame work these were situated within.

- Development Contributions (Local Government Act 2002) - *Not strictly value capture*
- Financial Contributions (Resource Management Act 1991)

- Targeted Rates (Local Government Rating Act 2002) – *Though these must be focused on specific groups who receive benefit and only for cost recovery*

The use of targeted rates may be possible for tax increment financing, however this could be subject to legal challenge depending on how it is structured (The Ministry of Transport, 2014). As shown in Table 3, and demonstrated in the research, New Zealand LVU scenarios would benefit from a betterment tax, or a land tax. These taxes provide a clear link to the value that is created through the LVU; they are captured in a predictable and equitable fashion; they can be timed to maximise the LVC; and they send price signals to the market to encourage the economic maximisation of space in our urban centres, discouraging sprawl (Lari et al., 2009). However, currently neither betterment tax or land tax are provided for by the government through legislation, and despite calls by Local Government in New Zealand for legislative review of the funding mechanisms available, central government remains reluctant to make any changes (LGNZ, 2015).

Context

Christchurch is largely built on the seaward edge of the alluvial Canterbury Plains, and at the feet of the Port Hills. Aside from these attributes its landscape is almost entirely built form and gardens, aside from a few rivers and streams. For most of the city, the street layout is in grid form and development has occurred largely in the form of concentric rings expanding outwards from the city centre, encapsulating villages as the city expanded. From 1954 onwards the city had a planning authority kept in place until the 1990s with the passing of the Resource Management Act. From this point on planning became less prescriptive and more market led (Wilson, Reed, & Mathews and mathews, 2005).

Since the 1990s, Christchurch has faced ongoing congestion as urban areas expanded rapidly on the outskirts of the city. If current trends continue it is expected that congestion will continue to get worse through to 2040. This is in part due to the large number of people who use private motor vehicles as their predominant travel mode. The City Council has identified that there is a key need to address these growing trends and provide for the people and businesses of Christchurch a network that enables efficient and easy movement around the city. They have four goals to achieve this: improve access and choice, create safe walkable communities, support economic vitality through easy movement, and enhance the natural environment. Whilst not explicitly stating it as an action point, the city council has identified that the northern access is a key public transport route, and three hubs exist along this route: Belfast, Papanui, and the City. A number of other links to the south, east, west, and south west have also been identified with hubs on each of these. In the Christchurch Transport Strategic Plan there is explicit mention of the need to work with the Greater Christchurch Urban Development Strategy Partners in order to study the future role for rapid transit in the region. Christchurch is also committed to retaining open corridors to allow for rapid transit in the future (CCC, 2012).

Following the destructive Christchurch earthquakes and subsequent Share an Idea participatory planning process in 2011, the city council drafted a Central City Recovery Plan (CCC, 2011). A strong recognition in this plan was given to the role that rail plays in creating urban spaces. There was explicit recognition that the reduction of car travel could result following implementation. This plan proposed to evaluate the options for utilisation of the heavy rail network for light rail through the north of the city to Rangiora. However, this plan was replaced with the Central City Recovery Plan produced by Canterbury Earthquake Recovery Authority in 2012. This latter plan reflected little on rail, focussing efforts into a new transport interchange built on the corner of Lichfield and Colombo Street. In the draft plan early feasibility work had indicated that it would be possible to upgrade the existing line and bring rail into the city, with an estimated cost of $400 million for the initial network and $1.5 to $1.8 billion for the 6 line network, reaching north to Rangiora, south to Hornby, east to Lyttelton and New Brighton, and west to the Airport.

The most recent study completed evaluated the possibility of utilising the old Auckland diesel train rolling stock and running a twice daily passenger service. This study came about after the trains were offered for Christchurch to purchase. The intention was for a route to run from Rangiora through to Addington following the main northern trunk line. Initial work did evaluate the requirements for double tracking, and some station costs. The estimation of building/upgrading stations was approximately $500,000. This study deemed that it was not feasible to operate the trains as proposed, in part due to the high costs, but also because of the long term risk of damaging the public perception of passenger rail by operating a sub-par service (Hardy & Eveleigh, 2014).

The Council also completed a study to look at how light rail might be used to link Papanui and Belfast to the city. This work, completed by Christchurch City Council (Strategic support unit, 2012), identified that it would be safer to operate light rail on-street rather than through the existing train network, due to incompatibilities with freight trains. The estimations in this report for costs of shared and exclusive right of ways were $24 – 66 million per kilometre. For commuter rail this cost was estimated at $1.5 - 7.5 million per kilometre. Vehicles cost $5 million for heavy rail, and $5 million for light rail. The summary of the northern corridor was that the existing heavy rail lines be used, with additional passing lanes and tracks added, or a new exclusive right of way be created along Papanui and Main north road with some shared sections. Other reports by Booz, Allen and Hamilton (Booz, 1998, 1999, 2007), have explored this topic over the years.

The main issue in providing a rail solution appears to be funding considerations. Politically and socially the heavy rail and light rail options appear very well supported through research, however with considerable budgetary constraints in place at the moment, the council cannot afford to implement any rail scheme alone. These budgetary conditions are linked to the banking covenants which restrict the level of debt the Council can attain with Local Government Funding New Zealand, preventing even borrowing for the cost of initiating transit (Cameron and Partners, 2014). This creates imperative need to seek an alternative funding mechanism to achieve implementation of light rail or a heavy rail passenger line to enable Christchurch to move away from automotive dependency. Shown in the figures below are maps of the two proposed transit lines and their associated catchments.

Christchurch Simulations

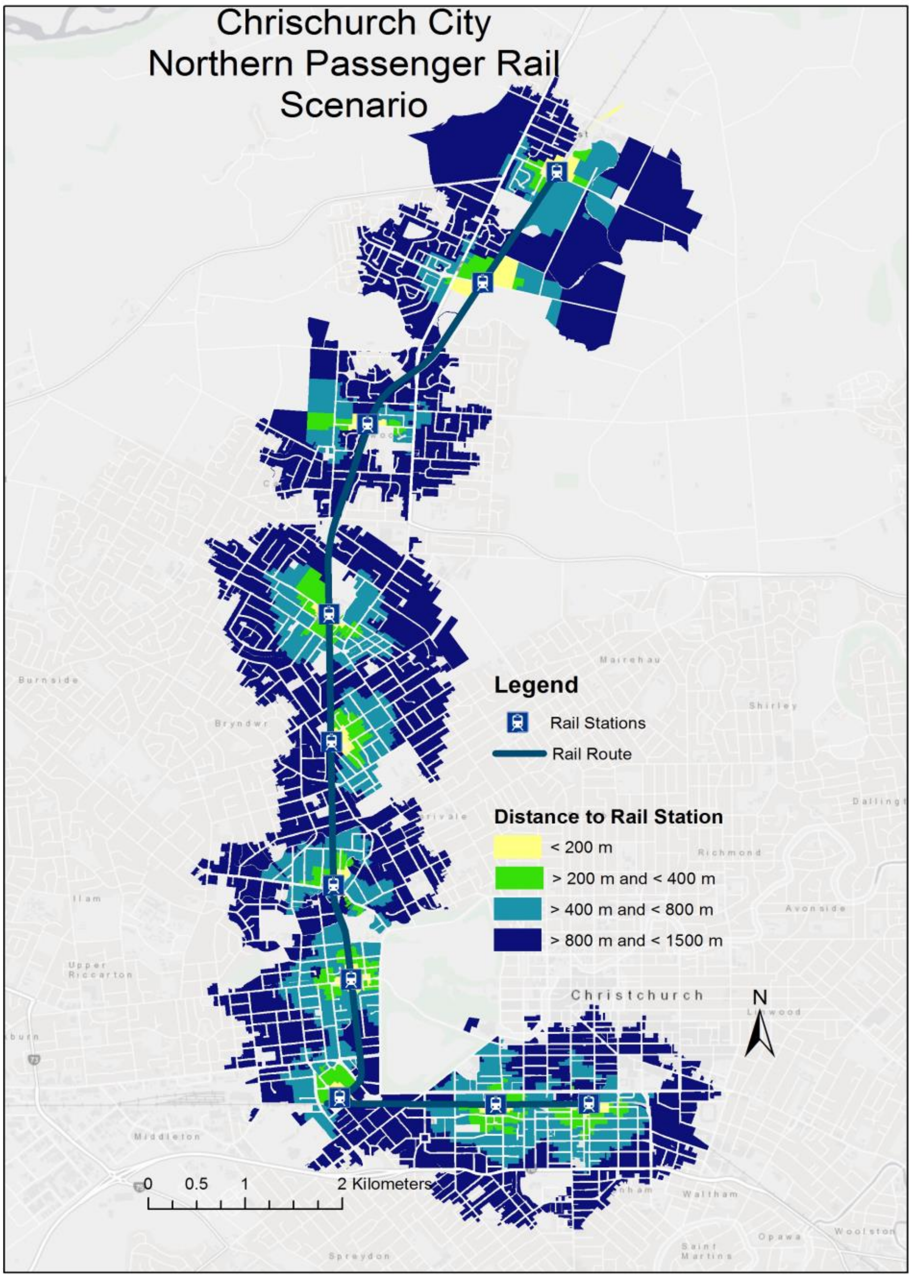

Figure 3 - Northern Passenger Rail scenario - Created by researcher

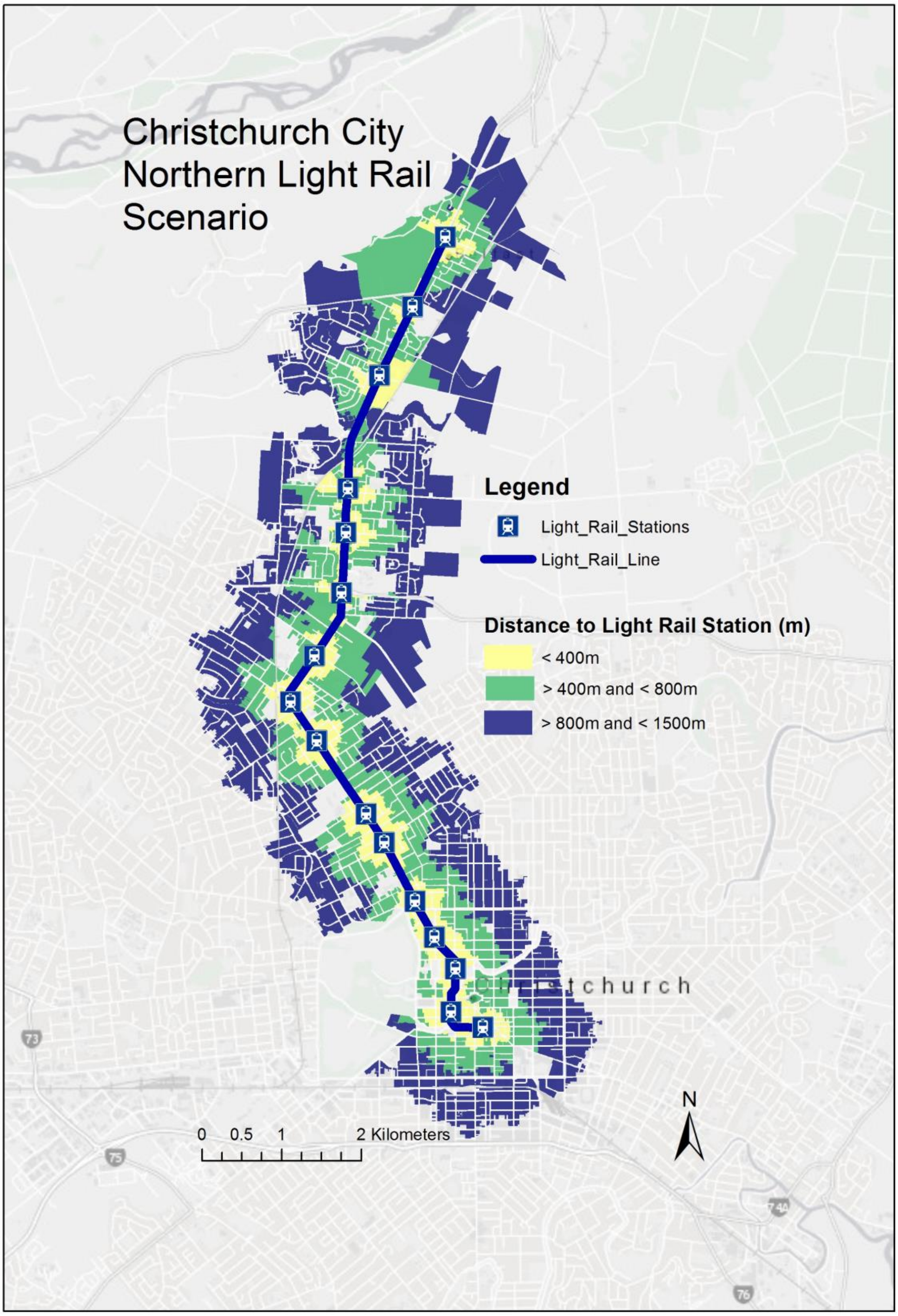

Figure 4 - Northern Light Rail Scenario - Created by researcher

Methodology

This methodology section introduces and summarises the methods and techniques that were used to answer the research questions posed by the objectives:

1. To identify through a literature review the potential for land value capture application within a New Zealand context and legislative framework.
2. To establish the best LVC application for use in a New Zealand context.
3. To estimate land value uplift on two simulated transit scenarios.
4. To develop an argument as to the potential for a land value capture application to be used to pay for the simulated transit options
5. To compare the likely built development outcomes as a result of the simulated transit implementation scenarios.

The first two objectives were addressed through the literature review, identifying both potential for land value capture, and also establishing the best land value capture application in a New Zealand setting. To achieve the remaining objectives and to address these questions that these objectives pose for this research, two simulations of transit infrastructure implementation along Christchurch's northern access corridor were developed. These simulations enable estimation through the use of a model, the hedonic price effects on land, to compare the impacts on development, and to develop an argument for the potential of a LVC method to fund the simulated transit proposals. The analysis level in which this research was carried out was at a property parcel level of spatial measurement. This provided for fine grain results showcasing likely spatial impacts at a specific parcel level. The model and the simulations required work in advance and the method is still somewhat undeveloped.

This methodology chapter begins with a discussion on the T-Improve method developed by Whelan (2003) that this research approach is based on, with an overview on the stages of research as they are carried out as per Whelan's method. This is followed by an outline of the source data used in the simulation, and an overview of the different data preparation and manipulation that was carried out.

A description of the model used to test the simulation, and a discussion of the assumptions used in the modelling and simulation is included prior to a methodology summary, describing how each of the stages relate to each other in order to produce the results.

Whelan’s T-Improve method

Whelan developed the Transport-Investment and Measurement of Property Value Enhancement (T-IMPROVE) method as a result of extensive literature review on the subject of land value capture (Whelan, 2003). This method is a three-staged approach to report analysis on the likely results from transit investment. These stages include a contextual analysis, quantitative analysis, and interpreted analysis, and each of these comprises three components. These are, contextual analysis: baseline conditions analysis, data assembly, and identification of possible schemes; the quantitative analysis: description of scheme, accessibility analysis, and GIS analysis; and the interpretive analysis: expert interpretation, stakeholder interpretation, and profile of land and value change associated with the transport scheme (Whelan, 2003). A diagram shown in figure 3 demonstrates how Whelan envisioned the T-IMPROVE methodology being employed. There are some components that are unable to be used in the analysis for this research for reasons such as the scope limitations and the slightly different focus of this research. These are mainly in the interpretive stage, and are discussed in a later section of this methodology, explaining how this was overcome.

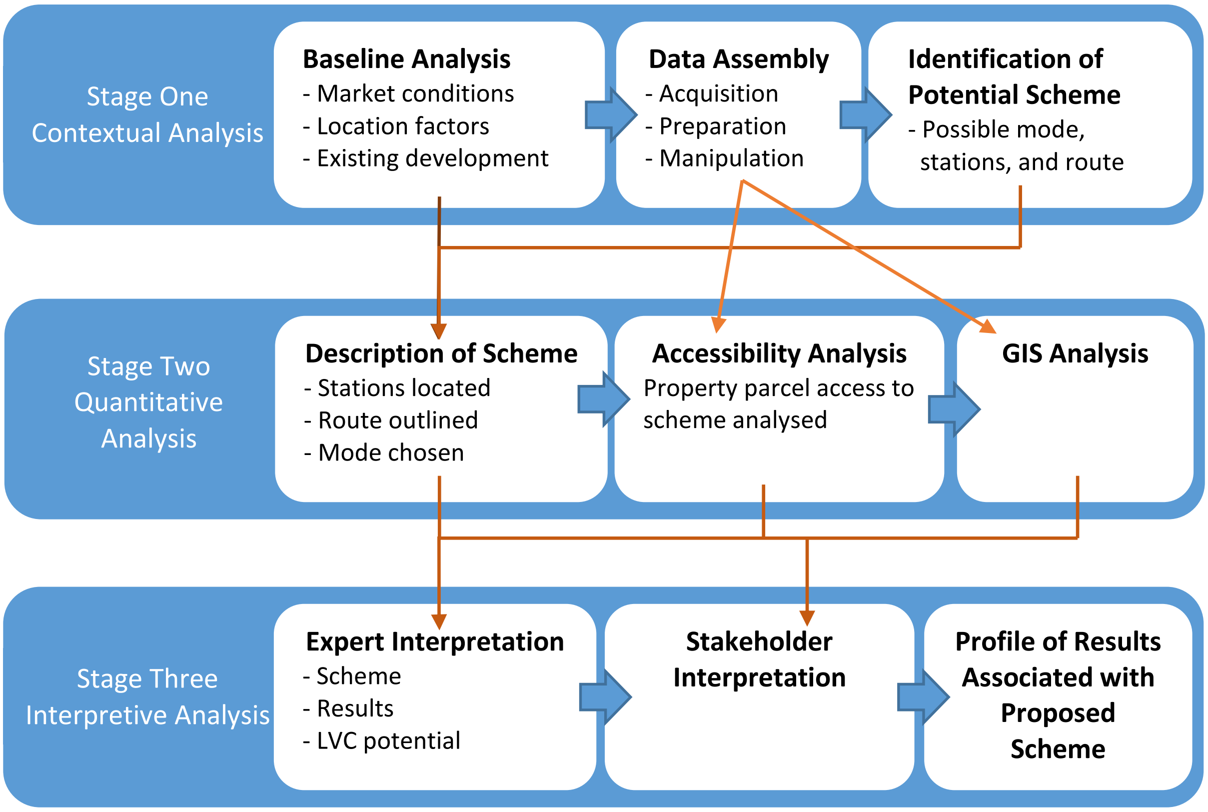

Figure 5: The Structure of T-IMPROVE methodology - Adapted from (Whelan, 2003) *– Created by Author*

No research, study, or commentary exists reviewing the T-IMPROVE methodology as developed by Whelan. As mentioned previously, methodological approaches for estimating the impacts of a simulated or theoretical transit line, with a LVC and LVU lens, are currently at an immature level. Whilst other works exist modelling the potential for existing lines to have used a LVC approach to fund and finance transit improvements (Mcintosh et al., 2014; Mittal, 2014; Mohammad et al., 2013), few studies exist for theoretical or simulated transit routes as is the case of this research. Macken and Williams (2015) estimated the land value impacts of a theoretical line solely by looking at a key individual site near a potential station, framing a discussion around how this could be used to fund the entirety of the transit improvement, without mentioning other potential LVU that might occur, other than in a general sense. Fickling and Brien (2009), in their study of a theoretical HRT line extension, adopted a methodological approach to explore the topic of value capture using a stated preference questionnaire sent to those households likely to be within a walking catchment of any new extension. They then used game theory to estimate the likely rent increase people would be willing to pay and extrapolated this into value uplift for the property. This approach was not considered for this research as it seemed unsuitable in a Christchurch scenario due to the current tenure profile in the city, coupled with a reluctance to approach individuals about a theoretical light rail line, which many people hope could be achieved, when there is no indication this is likely to be achievable in the short term given the current commitments of Christchurch City Council and the legislative framework infrastructure finance currently operates under in New Zealand.

The lack of an established and tested methodological approach meant this research utilised a modified T-IMPOVE methodology. Like Whelan's approach, this research was conducted in three stages: a contextual analysis stage, a quantitative analysis stage, and an interpretive analysis stage.

Stage 1 – A contextual analysis

In order to develop a model in a meaningful way, a baseline analysis utilising secondary data would be conducted. This stage was carried out to show a picture of what the current and underlying situation in the Christchurch land market is. Three interrelationships are demonstrated through these datasets: market conditions, location factors, and the current level of development. This contextual analysis creates a base for data upon which simulations can be created and identified. The contextual analysis consisted of the following:

Baseline analysis:

- Preparation of a property dataset for the Christchurch Territorial Authority Areas including the following information:
    - Parcel Size
    - Zoning type
    - Land Value
    - Capital Improvements Value
    - Decade Built
    - Building Area
    - Ownership (Government)
- Information on the current rating scheme for Christchurch City Council
- Information about the Christchurch City Council's existing borrowing and interest rates

Data Assembly:

- Data collected from numerous sources as described in Table 4
- Preparation of data to a parcel level

Scheme Identification:

- Initial survey of all previous, existing, and proposed mass transit schemes in Christchurch
- Selection of two schemes previously proposed, one HRT and one LRT.

Stage 2 – A Quantitative Analysis

Following the completion of the baseline analysis, the theoretical simulation of the two transit scenarios began. The output from these simulations would form the basis of the results and reporting. An accessibility analysis was completed to show parcels within walking catchments of new stations. A model was created to assess of effects of the simulated transit schemes on the adjacent parcels identified through the accessibility analysis. This model was based on the simulation and testing model of Gihing (2009), however, it was expanded so that research questions posed by this thesis could be answered. A full description of this modified model is shown in Table A. As with any model, it is only as accurate as the assumptions it is based on; presented in Table 5. In order to spatially show the effects of the simulated line, GIS analysis was completed. The steps in the quantitative analysis were:

Description of Scheme

- Identification of mode
- Routes identified
- Station locations initially identified in a desktop map survey, and previous location analysis
- Station locations confirmed through site visits by researchers
- Approximate costs of schemes estimated
- Stations and routes of the two simulations mapped as Shapefiles in Esri – ArcGIS – ArcMap 10.3.1

Accessibility Analysis

- Road network, baseline parcels, and station locations datasets uploaded in Esri – ArcGIS – ArcMap 10.3.1
- Distance from parcels to nearest station calculated as a network distance using Esri – ArcGIS – ArcMap 10.3.1 Network Analyst extension – Make Closest Facility Layer Tool.
- Data manipulated into distances of each model for each simulation and non-relevant parcels removed from analysis

Modelling Results

- Baseline results formatted to model
- Simulation One – Northern Passenger Rail service modelled – Land value uplifts estimated based on distance manipulations
- Simulation Two – Northern Papanui/Main North Road light rail modelled – Land value uplifts estimated based on distance manipulations
- Impact on development and redevelopment modelled

GIS Analysis

- Spatial representation of modelled results completed
- Map outputs produced

- Specific areas of high redevelopment potential highlighted for further investigation

Stage 3 – Interpretive Analysis

The interpretive analysis that was carried out in the course of this research differed significantly to that of Whelan's T-IMPROVE model. Where Whelan had engaged stakeholders and experts in interpretation of the simulations, this research has not due to the aforementioned limitations. Instead, this research reviews the baseline with the quantitative analysis results and completes a comparison of the differing outcomes against an application of LVC methodologies and the existing funding frameworks. This is then assessed against the research objectives.

The interpretive analysis involved:

Profile of Land & Value Changes

- The outcomes from the quantitative analysis are reported for each scheme
- Three methods of transit financing are tested against each scheme
- Timeframes and cost for each scheme estimated against scheme costs

Geography Information Systems

This simulation and modelling relied heavily on the use of Geography Information Systems (GIS), primarily the Esri software, ArcGIS – ArcMap 10.3.1 and several of its functions, tools, and extensions. GIS is a fundamental tool utilised in the modelling, analysis, and visualisation of spatial information, and has become a crucial tool for urban planning and urban economic research. The use of GIS allows, through visualisation of transit simulation, a simplified and interpretable platform upon which analysis can take place. The key research objectives of this thesis as outlined above have been answered and achieved through the use of GIS tools.

Data Sources

In order to construct a workable model in which analysis could be completed, several data sources were obtained and prepared. Aside from the plotted stations, and several assumptions used in the model, all data was obtained through secondary sources. Table 4 details the sources of each of these datasets.

Name	Description	Source
Street Centrelines	Christchurch road network – showing current street layout	GeoHealth Laboratory, University of Canterbury (Beere, 2015)
NZ Property Titles	Title information for all primary parcels in the Christchurch City Council Territorial Authority area	LINZ
Ratings valuation (2013)	A rating valuation for all properties within Christchurch City Council Territorial Authority area – including the valuation of land, the valuation of improvements, and the total capital valuation. This is calculated by QV using the following: - Land Use - Surroundings Quality - Percent sub-dividable - View-scape - Year Built - Roof material - Roof condition - Wall material - Wall condition - Roof material - Roof Condition - Foundation - Landscaping - Planning zone - Slope of land - Vehicle access - Dwelling Typology - Lot aspect - Lot orientation - Deck - Units - Laundry/Workshop/ Sundry buildings exist - Large improvements - Meshblock - Units of stock on site - Kg Milk Solids produced - Building Footprint - Outlier property - Bedroom number - Floor number - Toilet number - Carparks - Undercover car parking	CCC
Building	A dataset showing all the buildings in Christchurch City	CCC
Building age	A dataset showing the decade built for all building in Christchurch City	CCC
Government owned parcels	A dataset showing the ownership of any parcels by crown agencies, and local government agencies	MBIE
Zoning	The Zoning of parcels as described in the Christchurch City Plan	CCC
Railway centrelines	A dataset showing the railway centrelines in New Zealand	LINZ
Land Area	A dataset detailing the legal land area of a parcel	CCC

Table 4 - Data and Data sources used in analysis

Data Preparation

The secondary datasets provide the basis in which this research is built, and evaluation completed. To enable this to occur, data preparation and manipulation took place, coupled with the analysis of the constructed datasets. To prepare the baseline dataset that assessment could be made from, all data was clipped to the Christchurch City Council Territorial Authority area. Whilst extension to the dataset could have been completed to include the data for the Waimakariri District Council Territorial Authority Area, this was not included as the ratings systems vary between the two territorial authorities and it added a distracting complexity to the interpretation of results.

The shapefile of the New Zealand property titles, which is a dataset of primary parcels, acted as the base layer onto which other datasets were merged. Firstly, the ratings valuation dataset was merged using a spatial join of the data points to the parcel polygons. In situations where multiple units were recorded for single property parcel, the sum of the valuations was used. Where there were cases of a ratings valuation being split over several parcels, the parcel layer was modified to create a ratings valuation based joined parcel polygon. This was commonly the case for large properties where fragmented ownership had previously occurred. Strata titles were treated as if they were the same as fee simple parcels. The legal land area associated with each ratings unit was merged into the dataset record in-order to provide a measure of the developable area of each parcel.

To enable an assessment of the areas that would be possible to redevelop following land value uplift, a series of steps were undertaken. Building foot print information, as presently known, was merged into the dataset and, to each parcel, a building age was attributed. This step was only completed if improvement values were greater than $20,000; a limit set to remove uninhabitable buildings from the analysis. This building age was treated as the age of the primary built unit on a property. Where multiple units existed, the age of the newest unit was recorded. Small auxiliary units, and dwelling extensions were excluded.

The next stage of the dataset preparation involved the spatial merge of parcels with the City Plan Zoning. Once this step was completed, all property parcel files had a zoning code allocated to them, simplified into residential, commercial, industrial, open space, conservation, and special use. This step enabled properties that would not be suitable for redevelopment to be excluded from the results. For this, the work of Newton (2006), was used as a guide of parcels that are not suitable for redevelopment following transit upgrades. These were any conservation zones, open space zones, and special use zones. Additionally, parcels containing buildings under 25 years old were excluded. From the remaining dataset it is possible to then evaluate the redevelopment potential and therefore prospective building activity that would result following transit upgrades being completed.

Mapping the Transit Simulations

After the base datasets were completed, the simulated transit improvements were mapped by creating polygon, polyline, and point features showcasing the likely transit scenario of the LRT and the HRT. For the HRT, the station locations were determined by utilising the previous station locations on the line from when passenger services last operated. This decision was largely made to reduce potential development costs by reusing existing empty sites. Some additional stations were added to reflect new development that has occurred in the Addington cluster of businesses, and also the residential greenfield growth that has occurred in the South Belfast area. To enable network analysis, the point features that described the stations were tied to the nearest road along the Christchurch street centre lines network dataset.

For the LRT, a route was mapped along the existing B-Line bus route that travels into the central city transport interchange. It was assumed that any LRT would terminate at this point and that a northern terminus would be created in Belfast. The station locations for the LRT were decided upon in two stages. Firstly a desktop survey was undertaken that utilised information about resident populations from meshblock datasets and information about built form characteristics. These two pieces of information made it possible to map out the most suitable locations to place stations along this simulated route. The researchers then conducted an exercise where the route was travelled and at each point where a station was proposed, the area was examined against information in the Canterbury Earthquake Recovery Authority (2015) streets and spaces design guide, as to whether there was enough space to suitably site a station within the existing road reserve. This approach was selected as the purchasing of land for transit is a costly exercise, best avoided if possible. The station locations were finalised, and for each a shapefile was created in Arc-GIS, with the points spatially snapped to the road centreline along which the route travels. It would be expected, and highly recommended that more detailed scheme development and route design would be carried out. More specific accessibility demand calculations should be conducted for both of these lines, to determine the best location for stations that would best service the highest demand points along the route.

Transit Upgrade Evaluation Model

Gihring (2009) developed a model that can be used to simulate and describe the outcomes of transit investment. This model is the framework that the non-visualisation results have been reported with. It is also how the assumptions that have been used in the results have been reported. The tables below show how these simulations have been conducted, in addition to some discussion about why these assumptions have been chosen for each of the simulations.

Baseline model

Model Assumptions		
Characteristics	**Value**	**Notes**
Station Catchments	1500m	Calculated as a road network distance
Number of Parcels	#Residential, #Business	As calculated within network catchment
Sum Land Value (total)	$NZD (000)	2013 assessment of all parcels within catchment
Sum Improvement (total)	$NZD (000)	2013 assessment of all parcels within catchment
RDPI	Ratio	Redevelopment potential of total catchment by land value/total capital improvement value
Total Dev Ratio	Ratio	Ratio of Building area/Legal Land area (no-land constraints are addressed)
Current rates Land	$NZD (000)	Collection of 0.3179 cents per $ (standard), 0.527694 cents per $ (Business) *rural assessed as standard
Current rate Capital Impr	$NZD (000)	Collection of 0.3179 cents per $ (standard), 0.527694 cents per $ (Business) *rural assessed as standard

Table 5: Baseline model and assumptions - Source Researcher

Simulation One – Northern Passenger Rail

Model Assumptions		
Characteristics	**Value**	**Notes**
Catchment increments	200m, 400m, 800m, 1500m	Land segregated into catchments based on uplift factors
Total Station costs	$ per Station	Number of Stations
Total Rail Costs	$ per KM	Length of Line
Small Uplift		
Land Value Uplift 200m	Residential (-2%) Business 10%	As per (Grimes & Young, 2013; Mcintosh et al., 2014; Mohammad et al., 2013)
Land Value Uplift 400m	Residential 5% Business 10%	As per (McIntosh et al., 2013; Mohammad et al., 2013)
Land Value Uplift 800m	Residential 5% Business 6%	As per (McIntosh et al., 2013; Mohammad et al., 2013)
Land Value Uplift 1500m	Residential 2% Business 2%	As per (McIntosh et al., 2013; Mohammad et al., 2013)
Medium Uplift		
Land Value Uplift 200m	Residential 0% Business 20%	As per (Grimes & Young, 2013; Mcintosh et al., 2014; Mohammad et al., 2013)
Land Value Uplift 400m	Residential 10% Business 20%	As per (McIntosh et al., 2013; Mohammad et al., 2013)
Land Value Uplift 800m	Residential 10% Business 10%	As per (McIntosh et al., 2013; Mohammad et al., 2013)
Land Value Uplift 1500m	Residential 4% Business 5%	As per (McIntosh et al., 2013; Mohammad et al., 2013)
Large Uplift		
Land Value Uplift 200m	Residential 5% Business 35%	As per (Grimes & Young, 2013; Mcintosh et al., 2014; Mohammad et al., 2013)
Land Value Uplift 400m	Residential 20% Business 35%	As per (McIntosh et al., 2013; Mohammad et al., 2013)
Land Value Uplift 800m	Residential 10% Business 15%	As per (McIntosh et al., 2013; Mohammad et al., 2013)
Land Value Uplift 1500m	Residential 5% Business 10%	As per (McIntosh et al., 2013; Mohammad et al., 2013)
Redevelopment scenarios		
New RDPI	Ratio	Redevelopment potential of total catchment by Uplifted land value/total capital improvement value
Sum Total Land area Redevelopment parcels	SqM	All parcels with RDPI ratios of 0.7 or more (P. W. Newton, 2006)
Redevelopment Rate	50% of total	Only 50% of possible redevelopment will occur – This is in line with Land Use Recovery Plan and UDS estimates (Canterbury Earthquake Recovery Authority, 2013; *Greater Christchurch Urban Development Strategy UDS*, 2007)
Construction of Floor Area to Land Ratio	0.8 Residential	As per provisions for Medium density Housing (Christchurch City Plan, 2015)
Construction of Floor Area to Land Ratio	1.6 Business	Estimation (is reliant on whole site development, and multi-level development)
Construction costs	$2000 Sqm Residential $1000 Sqm Business	Estimations based on construction industry sources and recent building consents data – Both low value development
Taxation scenarios		
Increase in Rating Revenue Land	$(000)NZD	Collection of 0.3179 cents per $ (standard), 0.527694 cents per $ (Business) *rural assessed as standard
TIF borrowing interest rate	4.8% compounding Annually	As per Annual Plan 2016/17(CCC, 2016)
Loan Repayment Period	Years	

Table 6: Model assumptions for Northern Rail - Source Researcher

Simulation Two – Northern Light Rail

Model Assumptions		
Characteristics	**Value**	**Notes**
Catchment increments	400m, 800m, 1500m	Land segregated into catchments based on uplift factors
Total Station costs	$ per Station	Number of Stations
Total Light Rail Costs	$ per KM	Length of Line
Small Uplift		
Land Value Uplift 400m	Residential 1.2% Business 10%	As per (Mohammad et al., 2013)
Land Value Uplift 800m	Residential 5% Business 6%	As per (Mohammad et al., 2013)
Land Value Uplift 1500m	Residential 2% Business 2%	As per (Mohammad et al., 2013)
Medium Uplift		
Land Value Uplift 400m	Residential 10% Business25%	As per (Cervero & Duncan, 2002; GVA Grimley, 2004; Langley, 2015a)
Land Value Uplift 800m	Residential 7.5% Business 15%	As per (Cervero & Duncan, 2002; GVA Grimley, 2004; Langley, 2015a)
Land Value Uplift 1500m	Residential 5% Business 4%	As per (Cervero & Duncan, 2002; GVA Grimley, 2004; Langley, 2015a)
Large Uplift		
Land Value Uplift 400m	Residential 25% Business 45%	As per (Debrezion, Pels, & Rietveld, 2007; Pagliara & Papa, 2011)
Land Value Uplift 800m	Residential 17% Business 20%	As per (Debrezion et al., 2007; Mohammad et al., 2013; Pagliara & Papa, 2011)
Land Value Uplift 1500m	Residential 10% Business 5%	As per (Debrezion et al., 2007; Pagliara & Papa, 2011)
Redevelopment scenarios		
New RDPI	Ratio	Redevelopment potential of total catchment by Uplifted land value/total capital improvement value
Sum Total Land area Redevelopment parcels	SqM	All parcels with RDPI ratios of 0.7 or more (P. W. Newton, 2006)
Redevelopment Rate	50% of total	Only 50% of possible redevelopment will occur – This is in line with Land Use Recovery Plan and UDS estimates (Canterbury Earthquake Recovery Authority, 2013; *Greater Christchurch Urban Development Strategy UDS*, 2007)
Construction of Floor Area to Land Ratio	0.8 Residential	As per provisions for Medium density Housing (Christchurch City Plan, 2015)
Construction of Floor Area to Land Ratio	1.6 Business	Estimation (is reliant on whole site development, and multi-level development)
Construction costs	$2000 Sqm Residential $1000 Sqm Business	Estimations based on construction industry sources and recent building consents data – Both low value development
Taxation scenarios		
Increase in Rating Revenue Land	$(000)NZD	Collection of 0.3179 cents per $ (standard), 0.527694 cents per $ (Business) *rural assessed as standard
TIF borrowing interest rate	4.8% compounding Annually	As per Annual Plan 2016/17(CCC, 2016)
Loan Repayment Period	Years	

Table 7: Northern Light Rail Model and Assumptions – Source Researcher

Assumptions used in the models

As discussed in the previous section, the use of models is reliant on the assumptions made when creating them. The model used in this research is based on the work by Gihring (2009) and to cater to this research, the framework of Gihring's model was employed but assumptions were changed for each of the scenarios. The model was also extended to provide small, medium, and high LVU simulations. The information that forms the background of these simulations is from previous studies about the hedonic effects of transport on land values. The studies that have been used, as mentioned in the literature review, have been limited to spatial situations that are economically similar to Christchurch. There were, however, limitations to this, as there are not sufficient hedonic price studies that have been completed in an Australasian setting. Additional research is needed about how to standardise the modelling of the land value effects that transit implementation has. With the ever-increasing interest in the potential of LVC for transportation finance, being able to employ LVC methods in cities where no transport exists would be invaluable, but current research on the subject is limited.

Other assumptions made in the model have been better grounded in research. These include the redevelopment scenarios, which have been based largely on the works by Newton, and Murray et al. (2006; 2011). A report on the residential redevelopment in Christchurch has previously explored these assumptions in depth (Neville, 2014). Assumptions made about taxation and increases in rating revenue has been made utilising the CCC information, made available through the annual plan process. It should be noted that only the general rate was included in this information; the service specific rates were excluded including the uniform annual general charge, water supply targeted rate, water supply fire connection rate, the land drainage targeted rate, sewerage targeted rate, waste minimisation targeted rate, and the active travel targeted rate. Despite the fact that several of these rates are based on valuation, they all relate to specific services that are provided for. Lower value land units benefit by paying less for services in Christchurch, which could conversely hinder development, however, this is not explored in this thesis (CCC, 2016).

Putting the Methodology together

As this is a simulation of two potential transit scenarios, and a modelling of the estimated effects of these, the process had to come together in a number of stages. Firstly, there was a review of the types of transit that had resulted in LVU internationally, followed by a review of the levels of LVU that were experienced in these scenarios, and, finally, a review of the LVC methods, had they been employed. By building this international picture and establishing the relationship between land value and transit, and how this could be used in transit funding, this research was better guided, as if carried out as a research by design process, similar to that used in the field of urban design. Following the decision to complete a research study in Christchurch, the above information and the Christchurch contextual review enabled the transit scenarios to be decided upon. From this point the base dataset was collected with this in mind, and the transit scenarios could be modelled in Arc-GIS. The model of the simulations then began. Testing of these simulations, with the hypothesis of this research in mind, required a review of what the most appropriate LVC method to employ would be. It was for this reason, as described in the literature review, that a betterment tax, a business rate levy, and land value taxation/site value gain rating were chosen to analyse the modelled data against. As covered in the discussion, the betterment tax and the business rate levy are the two most likely candidates for fulfilling the hypothesis. The information generated by Gihring's (2009) model made it possible to carry out these tests against the hypothesis and Whelan's (2003) methodology became a useful framework to build the research case as presented here.

Results

Both proposed transit scenarios improve access to the central city from the north of Christchurch. They increase capacity on this generally congested route, and there would be an expectation from other studies as covered in the literature review that any transit improvement would result in LVU for nearby properties. This research utilises this assumption and makes an estimate on the likely land value uplifts by conducting three simulations for two transit scenarios. The first simulation uses a lower estimated uplift, the second simulation using a medium estimated uplift, and the third simulation utilising a high estimated uplift. Whilst it is difficult to assume which simulation would be applicable to Christchurch, the range of simulations allows for the scenarios to be interpreted, completing the application of Whelan's T-IMPORVE model (2009) and allowing for the hypothesis to be tested against the results.

Comparison of Transit Scenarios

The Northern Passenger Rail

Baseline Data

The northern passenger rail scenario envisions a 13,650m passenger rail service being initiated, with subsequent construction of a second track on the northern trunk line from Moorhouse Avenue, the southern termination, through to Belfast Road, the northern termination. This includes 11 proposed stations, each constructed on currently available parcels. It is not expected that any land needs to be purchased for the completion of this transit scenario.

This transit service had an assessed catchment of 1500 road network distance from each station. In this catchment there are 17,641 Parcels, however only 17,411 of them would likely be applicable to a LVC scheme, owing to their present use or ownership, as discussed in the methodology. The area of these eligible parcels was 36,918,669 square metres. The baseline total capital improved value (CIV) was $14,044,651,750, with an unimproved land value (ULV) of $7,226,029,250. This was split into 14,313 residential properties, with CIV $9,994,714,750 and ULV $5,277,428,250 with a total area of 28,431,300 square metres, and 3098 business parcels, with a CIV of $4,049,927,000 and an UIV of $1,948,601,000 on a land area comprising 8,487,369 square metres.

The catchment had a number of potentially re-developable parcels. In the baseline scenario there were 166 residential parcels with ULV of $89,929,000 and occupying 1,843,641 square metres of land. There were also 101 potentially re-developable business parcels, with an ULV of $78,937,000, over 1,843,641 square metres.

The baseline rating scenario is a total rates collection of $53,144,420 for eligible CIV of the parcels within the catchment. Of these rates $27,059,595 comes from the rating of the ULV of the parcels in the area. This is the figure that is affected by transit improvements and can be used in tax increment financing scenarios. The information about the baseline data for the northern passenger rail 1500m road network catchment can be located in Appendix 1.

Simulation 1 results – small estimated land value uplift

This simulation utilises that eligible parcels as in the baseline, and separates the data into four distance categories to enable interpretation, as discussed in the methodology. This information is contained in Appendix 2 as a table of the results produced from spatial analysis.

Under a small estimated LVU simulation the northern passenger rail would result in an uplift of values across the catchment as a whole. The total ULV following completion of the passenger rail would be $7,454,563,310 as simulated. This represents an uplift of $228,534,060 in land values, resulting in additional annual rating revenue of $907,489.00. Analysis of tax increment financing possibilities relating to this scenario will be discussed later in the results.

The increase in land values across the catchment also saw an increase in the number of parcels deemed to be ready for re-development, based on the ratio of the ULV/CIV = RDPI. 3832 properties would now fall into this category comprising 13,762,941 square metres. There is significantly more residential land ready for redevelopment than there is business land. If redevelopment occurs as per the assumptions made in the model, Table 6, this would result in 6,711,692 square metres of additional floor area being built, at a likely construction cost of $11,010,352,800. There were significant clusters of redevelopment ready parcels in Papanui, Belfast, Addington, and parallel to Moorhouse Avenue. Some of this redevelopment would be greenfield land in Belfast/Redwood Area.

Simulation 2 results – medium estimated land value uplift

Using the same parcels as in the previous simulation, a medium estimated land value uplift simulation would result in ULV increasing above and beyond the baseline data. In this scenario there would be an increase in land values across the catchment, and the total value of the catchment land would be $456,675,955 higher than in the base line. An additional $1,805,768 of rates would be collected from the increased land value. This increase in land value would likely make 4158 properties classifiable as ready for redevelopment as their RDPI score would exceed 0.7. If building activity was to occur as per the model assumptions this would result in 6,144,826 square metres of additional new floor area being constructed at a cost of $10,621,823,200.

Simulation 3 results – large estimated land value uplift

Using the same parcels as in the previous simulations, a large estimated land value uplift simulation would result in significant ULV increases from the baseline data. In this scenario there would be wide increases of land values across the catchment, with a total increase of $643,304,112, netting an additional $2,654,599 of rates on the increased land value. This increase in land value would likely make 4299 properties classifiable as ready for redevelopment as their RDPI score would exceed 0.7. If building activity was to occur as per the model assumptions this would result in 7,213,613 square metres of additional new floor area being constructed at a cost of $11,722,584,000.

Potential for Land Value Uplift to be used to fund Northern Passenger Rail

As discussed in the context section, the likely cost per kilometre for passenger rail would be approximately $20 million per kilometre to upgrade the line to dual track and update signalling and road crossings, coupled with the cost of $500,000 per station and $12 million for six carriages. This scenario would therefore require funding of $290 million dollars. When reviewing this against the LVU simulations above, the LVU in simulation 1 is less than the cost of implementation. In simulation 2 the costs represent 63% of the LVU, and in simulation 3 the costs represent a mere 45% of the estimated LVU. These are still significant proportions of the land value benefits resulting from the infrastructure, which may make it difficult to develop a viable LVC strategy.

Northern Light Rail

Baseline Data

The northern light rail scenario is an envisioned 11,400m light rail service that runs along a dedicated corridor through much of its route, with a termination in Belfast at Richill Street, and a southern termination in the Central City at the bus Interchange on Lichfield Street. It is anticipated for this light rail to have 16 stations each servicing a catchment of 1500m. No land would be purchased for the purposes of station construction; this would solely occur in the road reserve. The information on the baseline, upon which these scenarios were based, is included in Appendix 3.

This transit service had an assessed catchment of 1500 road network distance from each station. In this catchment there was 19,196 parcels, however only 18,919 of them would likely be applicable to a LVC scheme, owing to their present use or ownership, as discussed in the methodology. The area of these eligible parcels was 39,801,835 square metres. The baseline total CIV was $17,502,281,300, with an ULV of $8,737,054,950. This was split into 15,757 residential properties, with CIV $11,313,984,323 and ULV $5,860,830,000 with a total area of 11,101,783 square metres, and 3162 business parcels, with a CIV of $5,498,104,069 and an ULV of $2,602,206,950, with a total land area of 7,857,531 square metres.

The catchment had a number of potentially re-developable parcels. In the baseline scenario there were 166 residential parcels, with ULV of $89,929,000 and occupying 1,843,641 square metres. There were also 3,829 potentially re-developable business parcels, with an ULV of $2,751,622,000, over 13,826,587 square metres.

The baseline rating scenario is a total rates collection of $64,980,321 for eligible CIV of the parcels within the catchment. Of these rates $32,363,268 comes from the rating of the ULV of the parcels in the area. This is the figure that is affected by transit improvements and can be used in tax increment financing scenarios. The information about the baseline data for the northern passenger rail 1500m road network catchment can be located in Appendix 1.

Simulation 1 results – small estimated land value uplift

For the light rail scenario a simulation was run that had a small land value uplift. This resulted in LVU occurring over the catchment but at a lower rate than what is possible. With light rail the risk of land value decrease at very close proximity was not deemed likely, as was assessed in the simulations in the passenger rail scenario.

The ULV in total for simulation 1 was $8,796,840,083, reflecting a LVU of $59,785,133 as compared with the baseline scenario. With such uplift comes an increase in rates as applied to the increased land valuation. This increased rates revenue was $1,407,572, which was a mixture of residential and business uplift. The resultant land value uplift also meant that a number of properties in the catchment under this simulation would be deemed redevelopment ready. This included 4141 properties, on 14,814,090 square metres of land in simulation 1. If the model assumptions are to be used this would result in 7,220,830 square metres of development taking place, with an associated potential construction cost of $11,851,272,000.

Simulation 2 results – medium estimated land value uplift

As with simulation 1, simulation 2 was run on the same set of parcels however a medium factor of uplift was used in land valuation calculations. The results are shown in appendix 4.

The total ULV that was modelled for simulation two was $9,236,380,598, reflecting a LVU of $499,325,648 as compared with the baseline scenario. With such uplift comes an increase in rates as applied to the increased land valuation. This increased rates revenue was $3,307,365, which was a mixture of residential and business uplift. The resultant land value uplift also meant that a number of properties in the catchment under this simulation would be deemed redevelopment ready. In simulation 2, this included 4565 properties, on 15,591,098 square metres of land. If the model assumptions are to be used this would result in 7,613,169 square metres of development taking place, with an associated potential construction cost of $12,424,878,400.

Simulation 3 results – large estimated land value uplift

Simulation 3 is a large estimated LVU, when compared to simulations 1 and 2. For this simulation the total modelled ULV that was $9,868,556,217, reflecting a growth in land values of $1,131,501,267. This is a significant increase in land valuation and is the greatest across both scenarios and all simulations. As a result of this LVU in the ULV, the rating potential increased by $5,849,076 compared with the baseline rates collected in the ULV for the catchment. There were also significant development outcomes in this simulation, as the large increase in land values meant many properties then qualified as ready to redevelop; 5347 in this case. With this level of redevelopment as per the assumptions in the model, 8,172,984 square metres of new floor area would be created, with an estimated construction cost of $13,515,916,000. If this construction were to go ahead it would represent almost 40% of the total built development within the catchment.

Potential for Land Value Uplift to be used to fund Northern Passenger Rail

As discussed in the context, Christchurch has carried out a number of studies to explore light and heavy rail options and some costs have been estimated for this. In the case of a northern light rail, the likely costs include: $20 million for the track per kilometre, $5 million each for 6 locomotives, and $1 million for each station. This would make the likely cost of development $274 million dollars. At this cost, the LVU in simulation 1 does not exceed the cost of transit. However, the LVU in both simulations 2 and 3 was significantly higher than the cost of implementation. When comparing these costs against the increase in rates revenue it is difficult to see how this could be afforded with rates alone. Certainly with a large LVU, tax increment financing appears viable, pending legislative change. In all other simulations, funding would need to be found from other sources.

Discussion

The hypothesis of this thesis is that a land value capture method could be employed to fund future mass transit in New Zealand. This is certainly possible though a number of challenges would need to be overcome first. Initially, as identified in the literature review, there is a need for legislative change to enable local bodies to raise revenue through different mechanisms. Land value capture methods such as betterment levies are not provided for in the current legislation, and can be legally challenged if clear links to spending are not established. Even when tax increment financing is used, a non-value capture approach that uses only uplifted rating assessment can be the subject of litigious review. This creates a burden for councils, hindering their ability to explore innovative funding mechanisms and to use means that have the potential outside the current framework.

If New Zealand local bodies could have the choice to utilise other sources of funding there is great potential for the use of land value capture. Aside from air rights, co-development, development of council land, and government owned land, there are several other land value taxation methods that could be used to fund transit. The most appropriate, as seen in this research, would be the use of a betterment levy, imposing an annualised levy on the land value uplift that had been experienced by a property. Despite the significant potential, there are some drawbacks, and care needs to be taken to ensure that it is not becoming regressive on smaller land holdings. Councils would need to become more informed about land value uplift and the rate at which this occurs, and to which properties uplift is occurring. As identified by Higgins & Kanaroglou (2016), betterment levies need to be applied early into the process to capture the speculative uplift that occurs before transit is operational. Looking at the simulated results, a betterment levy of 20% of the land value uplift could yield from $11 million to over $100 million annually in the light rail scenario. Whilst this is considerably higher than present council rates, it is reflective of the increase in property values experienced. These substantial figures are perhaps a cause for concern about introducing local government to land value capture tool kits and methods. Both New Zealand Institute of Economic Research (Drew, 2014) and the Ministry of Transport (2014) do point to this in their assessment of future tools. Perhaps it is more appropriately a governmental role to enact land value capture mechanisms, however this does limit the local voice in decision-making, which would be cautioned from a place making perspective.

The scenarios as selected and the simulations that were run on these do present a case where even in moderate value uplift situations, there is still room for land value taxation to be effective. The transit lines as they were selected for the Christchurch scenario have a high likelihood of being successfully adopted into the transportation culture of Christchurch, given the continued pressure that has been placed on elected officials to explore options for these. The several reports that have been completed over the years since the nineties also indicate appetite from a local body level for such an activity to take place (Booz, 1998, 1999, 2007; Hardy & Eveleigh, 2014; Strategic support unit, 2012). In this setting it is reasonable to assume that some land value uplift would therefore likely occur as people are already stating a willingness to pay for such services. The proposed transit routes currently suffer from congestion and, in the case of light rail, the movement of cars will be further hindered by the light rail line taking up road space. It would be expected that people would therefore move onto the light rail as a mode of transit at a faster rate than the uptake of rail. A deeper understanding of mode choice is needed to fully complete this picture and would also allow for the land value uplift estimations to be made more accurately.

Undoubtedly the most difficult task in this research has been deciding on an estimate for land value uplift. This has been discussed heavily in the literature review, the biggest hurdle that must be overcome is the lack of cohesion amongst willingness to pay studies. In the methodology it was also discussed how the estimation was an undeveloped field in working out what value of uplift to apply to scenarios where the transit line had yet to be installed. This is an area of research that will be increasingly necessary as more cities around the world begin to explore if land value capture could work for them. Whelan's (2003) T-IMPROVE model provided a lens through which the research could be framed, but undocumented here in this thesis are the countless studies reviewed of international light rail and passenger rail value uplifts that might occur. Always, situations were found to be different and contexts did not quite fit Christchurch. This is a concern as this research has been undertaken over a long time period with substantive exploratory review enabling a fair and educated approximation of the uplift to be made. When reports are prepared on topics like value capture they are generally completed in a time sensitive fashion, precluding the in-depth level of research called for by the T-IMPROVE model. A good example of this limitation is the work by Kemp et al., (2013), one of three texts specific to New Zealand to deal with value capture, with the authors incorrectly identifying some revenue raising mechanisms as value capture approaches, when they are not.

The research could have been effectively deconstructed further to provide a much broader and more comprehensive basis as to the understanding of a number of underlying assumptions. Whilst assumptions that made up the methodology were sound in the context of testing the hypothesis, they would not be suitable to build a land value capture framework from. The most glaring example of this is the crude multipliers for redevelopment of land where the properties have a RDPI of 0.7 or greater. As the land values increased the value of the improvements in relation to the land fell as a ratio. This meant that parcels would therefore become more attractive to develop into new residential and commercial spaces. Multipliers were arrived at based on TOD style development outcomes as zoned for in the Christchurch city plan. These were coupled with the estimated infill rates for the Christchurch City Council replacement district plan. In the results this equates to many million square metres of development and billions of dollars worth of construction activity. These numbers, however, are grossly overstated and the simulations do not take into account the nuances that the current zoning overlays have on the land, the development density changing throughout the city, and the pure economic reality of there just being a lack of demand for such large amounts of redevelopment to occur. This development is unlikely to eventuate and hence these did not make it into estimations about the tax revenue increase that would be possible following transit improvements. As this could not be included it became difficult to calculate an effective tax incremental financing arrangement that could be implemented. These arrangements would arrive only at results much lower than half the capital cost of the transit, at bonds over thirty year periods. If future development could have been more realistically projected then it may have been possible to show how tax increment financing may work, through hypothecating uplifted land value rate assessments.

Two key findings have been made from the information about the possible built form scenarios. Firstly, that there are significant clusters of redevelopment. For the rail line these clusters exist in Papanui, where at present significant surface parking exists; in Belfast and Redwood, which could be the source of transit linked greenfield development; and through the Addington-Moorhouse area in which there is the possibility of brownfield and mixed used redevelopment. For the light rail there are clusters in Papanui, Belfast, and the Central City; which is unsurprising given the current number of vacant lots. The second finding is more an interpretive conclusion in that density will be key to the success of either transit option. Ginn (2010), discusses this matter in his conference paper on the subject. His focus was more on achieving operational outputs whereas this research also sees that this is necessary for achieving land value growth; the demand, as described by the bid-rent model.

To enable transit orientated development and to reduce automotive dependency there is pressing need for mass transit and supportive zoning. Whilst this thesis did not explore the likely reduction in kilometres travelled, this would be an area in which further research could be done. The thesis did highlight two core points on this, however. The first is the need for comprehensive land-use and transport planning. The independent hearing panel process for deciding the replacement Christchurch City Plan is currently underway. This involves up-zoning large areas of the proposed station catchment in Papanui to medium density residential (*The proposed replacement distrcit plan*, 2015). Should this development occur, it could limit both the prospect for a successful value capture framework but also the opportunity for higher density transit orientated development. Transit needs to be completed in conjunction with land use planning to achieve the maximum gain. Whilst passenger rail as proposed would be easier in terms of having fixed infrastructure, it would likely yield lesser results in terms of increasing density and land value uplift. From Papanui to Addington the existing rail goes through a very established residential section of the city and this form is unlikely to change quickly to maximise value outcomes. The light rail, however, runs along a route that has already seen significant density increase and is being zoned for even more uplift. Should the light rail proceed it is likely to be one of the first cases in the city of transit orientated development actually occurring.

Limitations with this research

This research had a number of limitations, which have produced results that could be improved on. The primary limitation was a lack of data, firstly with regards to property valuation, and further, with regards to residential and business redevelopment. The property valuations based on market price movements were sought for this research, so that work could be conducted building a willingness to pay analysis for Christchurch. The valuation data that is provided is used for rating but is sometimes markedly different from market valuations. This data was becoming too old to be utilised for a Hedonic Price model of other transport methods, meaning that no Christchurch specific hedonic modelling was carried out. This has left the methodology open for criticism in that it does not relate to a specific scenario, despite this being a lesson learned from international case studies. This data was not available due to it being commercially owned, with the company not seeing the value in providing access for research purposes. The next data limitation is a lack of redevelopment scenarios that relate specifically to Christchurch. Despite some estimations being provided in the district plan, there is little other information about the redevelopment of existing properties into new uses, and the 'risk' factors for this to occur. The scenarios used in this model have therefore been based on the research conducted for greening the greyfield (P. W. Newton, 2006; P. Newton et al., 2012).

Further Research suggestion

Based on the limitations of this research and also the results, there are a number of recommendations for further research to be carried out. These include: state preference theory and other modelling work to use as a predictive measure of the reduction in car use as a result of transit; studies that relate more closely to New Zealand scenarios about the willingness to pay for transit infrastructure, ideally of Auckland infrastructure utilising hedonic modelling to give results; and research into the redevelopment and intensification potential for land. There is a need to move away from a crude economic basis to develop predictive measures that relate specifically to Christchurch.

At a broader level, looking over the field of value capture, more studies could take place in relation to meta-analysis, and previous research works could be recompleted to see if the results from the numerous studies on the subject of willingness to pay and land value uplift could be synthesised into a confidently reportable body of work. I suspect there would be a need for this research to be completed using hedonic price modelling, geographic weighted regression, and repeat sales methods, as all three continue to be used in the field of study.

The last suggestion for further study is into the legislative and political barriers to change central government's mind set on land value legislation. Whilst other areas create complexity in analysis, the lack of a legislative green light has created a situation where several case studies could have been completed to trial a land value capture approach but all have failed to go ahead.

Conclusion

The hypothesis of this research is that a land value capture method could be employed to fund future mass transit in New Zealand cities. Through two scenarios in Christchurch this hypothesis was tested to evaluate the likely outcomes of transit with a number of land value uplift simulations. These simulations showed that there would be value uplift, which would be significant enough to fund transit, depending on the value capture method employed. On a numbers based scenario, the outcome of the thesis is that the hypothesis is correct. However, when we explore further into the ability for local bodies in New Zealand to be able to self-determine, we find that they are hampered by strict regulation that does not allow for innovative means of transport funding to be used.

The literature review and the contextual analysis definitely point to the fact there is solid demand for value capture to be explored further. A number of recommendations have been made into further research that could follow or where this research has been lacking both at the analysis stage and at a level where better data provision would have contributed to improved knowledge in certain areas. For New Zealand cities to improve their productivity and economic prospects we will need to find ways in which we can innovate when it comes to transport provision and funding.

Appendix 1. Northern Passenger Rail

Variable	Value	Notes
Distance	13650	Metres
Stations	11	Stations
Northern Terminus	Belfast	Belfast Road
Southern Terminus	Moorhouse Avenue	Colombo Street Overbridge
Grade	Flat	Slope
Corridor	Available	NZ railways corporation ownership
Alignment	Straight	*Aside from Tower Junction

Baseline

Total Parcels within 1500m Road Network Catchment	17641	Parcels
Area	43827951	Square metres
Total Capital Value	$15,002,531,750.00	NZD 2013
Total Land Value	$7,465,880,250.00	NZD 2013

Eligible Parcels

Total Eligible Developable parcels	17411	Parcel
Area		Square metres
Total Capital Value	$15,002,531,750.00	NZD 2013
Total Land Value	$7,465,880,250.00	NZD 2013

Total Residential

Parcels	14313	Parcels
Area	28431300	Square metres
Total Capital Value	$9,994,714,750.00	NZD 2013
Total Land Value	$5,277,428,250.00	NZD 2013
Redevelopment ready	166	Parcels
RR area	1843641	Square metres
Redevelopment ready Land Value	$89,929,000.00	NZD 2013
Current Improvements	$18,296,000.00	NZD 2013

Total Business

Parcels	3098	Parcels
Area	8487369	Square metres
Total Capital Value	$4,049,927,000.00	NZD 2013
Total Land Value	$1,948,601,000.00	NZD 2013
Redevelopment ready	101	Parcels
RR area	282659	Square metres
Redevelopment ready Land Value	$78,937,000.00	NZD 2013
Current improvements	$583,000.00	NZD 2013

Current Rates

Residential rates Cap	$31,773,198.19	NZD 2013
Business rates Cap	$21,371,221.78	NZD 2013
Total	$53,144,419.97	NZD 2013

Residential rates Land	$16,776,944.40	NZD 2013
Business rates Land	$10,282,650.56	NZD 2013
Total (included in Cap above)	$27,059,594.96	NZD 2013

Appendix 3. Northern Light Rail Baseline

Variable	Value	Notes
Distance	11400	Metres
Stations	16	Stations
Northern Terminus	Belfast	Main North Road/Richill Street
Southern Terminus	CBD	Bus Interchange - Lichfield Street
Grade	Flat	Slope
Corridor	Available	Road Reserve (Tight in Merivale)
Alignment	Along Road corridor	Significant curve at Main North Road/Papan
Baseline		
Total Parcels within 1500m Road Network Catchment	19196	Parcels
Area	45411897	Square metres
Total Capital Value	$17,502,281,300	NZD 2013
Total Land Value	$8,737,054,950	NZD 2013
Eligible Parcels		
Total Eligible Developable parcels	17411	Parcel
Area	39801835	Square metres
Total Capital Value	$16,812,089,300	NZD 2013
Total Land Value	$8,463,036,950	NZD 2013
Total Residential		
Parcels	15757	Parcels
Area	31944303	Square metres
Total Capital Value	$11,313,984,323	NZD 2013
Total Land Value	$5,860,830,000	NZD 2013
Redevelopment ready	2639	Parcels
RR area	11101783	Square metres
Redevelopment ready Land Value	$1,478,047,300	NZD 2013
Current Improvements	$262,333,600	NZD 2013
Total Business		
Parcels	3162	Parcels
Area	7857531	Square metres
Total Capital Value	$5,498,104,069	NZD 2013
Total Land Value	$2,602,206,950	NZD 2013
Redevelopment ready	1190	Parcels
RR area	2724804	Square metres
Redevelopment ready Land Value	$1,273,574,700	NZD 2013
Current improvements	$80,272,000	NZD 2013

Current Rates

Residential rates Cap	$35,967,156	NZD 2013
Business rates Cap	$29,013,165	NZD 2013
Total	$64,980,321	NZD 2013

Residential rates Land	$18,631,578	NZD 2013
Business rates Land	$13,731,689	NZD 2013
Total (included in Cap above)	$32,363,268	NZD 2013

Apendix4. Northern LRT Results

$ NZD	SIM1	Sim2	Sim3
LANDBUS400	$1,144,961,895	$1,301,093,062	$1,509,267,952
LANDBUS800	$789,851,580	$856,914,450	$894,171,600
LANDBUS1500	$832,513,290	$848,837,080	$856,998,975
LANDRes400	$1,083,447,706	$1,177,660,550	$1,338,250,625
LANDRes800	$2,101,103,288	$2,151,129,556	$2,341,229,378
LANDRes1500	$2,844,962,325	$2,900,745,900	$2,928,637,688

Sub Total Business	$2,767,326,765	$3,006,844,592	$3,260,438,527
Sub Total Residential	$6,029,513,319	$6,229,536,006	$6,608,117,690
Total	**$8,796,840,084**	**$9,236,380,598**	**$9,868,556,217**

# of Redevelopment ready Parcels	SIM1	Sim2	Sim3
RDPI_Bus_400_Parcels	$419	$445	$488
RDPI_Bus_800_Parcels	$422	$450	$467
RDPI_Bus_1500_Parcels	$397	$409	$414
RDPI_Res_400_Parcels	$486	$633	$976
RDPI_Res_800_Parcels	$960	$1,055	$1,396
RDPI_Res_1500_Parcels	$1,457	$1,573	$1,606

Sub Total Business	$1,238	$1,304	$1,369
Sub Total Residential	$2,903	$3,261	$3,978
Total	**$4,141**	**$4,565**	**$5,347**

SqM - Redevelopment ready land	SIM1	Sim2	Sim3
RDPI_Bus_400_Area	$715,768	$779,587	$842,181
RDPI_Bus_800_Area	$858,176	$980,640	$1,001,787
RDPI_Bus_1500_Area	$1,664,043	$1,681,599	$1,693,597
RDPI_Res_400_Area	$858,765	$1,098,616	$1,613,188
RDPI_Res_800_Area	$3,527,257	$3,680,113	$4,199,818
RDPI_Res_1500_Area	$7,190,081	$7,370,543	$7,544,324

Sub Total Business	$3,237,987	$3,441,826	$3,537,565
Sub Total Residential	$11,576,103	$12,149,272	$13,357,330
Total	**$14,814,090**	**$15,591,098**	**$16,894,895**

SqM - Redevelopment Construction	SIM1	Sim2	Sim3
RD_New_FArea_Bus_400_Area	$572,614	$623,670	$673,745
RD_New_FArea_Bus_800_Area	$686,541	$784,512	$801,430
RD_New_FArea_Bus_1500_Area	$1,331,234	$1,345,279	$1,354,878
RD_New_FArea_Res_400_Area	$343,506	$439,446	$645,275
RD_New_FArea_Res_800_Area	$1,410,903	$1,472,045	$1,679,927
RD_New_FArea_Res_1500_Area	$2,876,032	$2,948,217	$3,017,730

Sub Total Business	$2,590,390	$2,753,461	$2,830,052
Sub Total Residential	$4,630,441	$4,859,709	$5,342,932
Total	**$7,220,831**	**$7,613,170**	**$8,172,984**

	SIM1	Sim2	Sim3
Rate_Land_BUS400	$6,041,895	$6,865,790	$7,964,316
Rate_Land_BUS800	$4,167,999	$4,521,886	$4,718,490
Rate_Land_BUS1500	$4,393,123	$4,479,262	$4,522,332
Rate_Land_Res400	$3,444,280	$3,743,783	$4,254,299
Rate_Land_Res800	$6,679,407	$6,838,441	$7,442,768
Rate_Land_Res1500	$9,044,135	$9,221,471	$9,310,139

Sub Total Business	$14,603,017	$15,866,939	$17,205,138
Sub Total Residential	$19,167,823	$19,803,695	$21,007,206
Total	**$33,770,840**	**$35,670,633**	**$38,212,345**

$ NZD - Redevelopment Construction	SIM1	Sim2	Sim3
New_Const_cost_Bus_400_Area	$572,614,400	$623,669,600	$673,744,800
New_Const_cost_Bus_800_Area	$686,540,800	$784,512,000	$801,429,600
New_Const_cost_Bus_1500_Area	$1,331,234,400	$1,345,279,200	$1,354,877,600
New_Const_cost_Res_400_Area	$687,012,000	$878,892,800	$1,290,550,400
New_Const_cost_Res_800_Area	$2,821,805,600	$2,944,090,400	$3,359,854,400
New_Const_cost_Res_1500_Area	$5,752,064,800	$5,896,434,400	$6,035,459,200

Sub Total Business	$2,590,389,600	$2,753,460,800	$2,830,052,000
Sub Total Residential	$9,260,882,400	$9,719,417,600	$10,685,864,000
Total	**$11,851,272,000**	**$12,472,878,400**	**$13,515,916,000**

Appendix2. Northern Passenger Rail Results

$ NZD	SIM1	Sim2	Sim3
LANDBUS200	$61,316,200	$66,890,400	$75,251,700
LANDBUS400	$206,807,700	$225,608,400	$253,809,450
LANDBUS800	$736,529,870	$764,323,450	$799,065,425
LANDBUS1500	$1,030,212,750	$1,060,513,125	$1,111,013,750
LANDRes200	$83,410,250	$85,112,500	$89,368,125
LANDRes400	$231,202,125	$242,211,750	$264,231,000
LANDRes800	$1,173,154,500	$1,229,019,000	$1,229,019,000
LANDRes1500	$3,931,929,915	$4,009,026,580	$4,047,574,913

Sub Total Business	$2,034,866,520	$2,117,335,375	$2,239,140,325
Sub Total Residential	$5,419,696,790	$5,565,369,830	$5,630,193,038
Total	**$7,454,563,310**	**$7,682,705,205**	**$7,869,333,363**

# of Redevelopment ready Parcels	SIM1	Sim2	Sim3
RDPI_Bus_200_Parcels	16	19	28
RDPI_Bus_400_Parcels	72	82	98
RDPI_Bus_800_Parcels	303	323	354
RDPI_Bus_1500_Parcels	545	564	600
RDPI_Res_200_Parcels	52	56	63
RDPI_Res_400_Parcels	167	183	225
RDPI_Res_800_Parcels	713	821	821
RDPI_Res_1500_Parcels	1964	2110	2110

Sub Total Business	936	988	1080
Sub Total Residential	2896	3170	3219
Total	**3832**	**4158**	**4299**

SqM - Redevelopment ready land	SIM1	Sim2	Sim3
RDPI_Bus_200_Area	180788	187480	202395
RDPI_Bus_400_Area	335060	373632	402619
RDPI_Bus_800_Area	1363441	357751	1451395
RDPI_Bus_1500_Area	1137001	1165925	1324394
RDPI_Res_200_Area	246854	251477	261729
RDPI_Res_400_Area	283067	325775	395459
RDPI_Res_800_Area	1739192	1899048	1899048
RDPI_Res_1500_Area	8477538	8716191	8716191

Sub Total Business	3016290	2084788	3380803
Sub Total Residential	10746651	11192491	11272427
Total	**13762941**	**13277279**	**14653230**

SqM - Redevelopment Construction	SIM1	Sim2	Sim3
RD_New_FArea_Bus_200_Area	144630.4	149984	161916
RD_New_FArea_Bus_400_Area	268048	298905.6	322095.2
RD_New_FArea_Bus_800_Area	1090752.8	286200.8	1161116
RD_New_FArea_Bus_1500_Area	909600.8	932740	1059515.2
RD_New_FArea_Res_200_Area	98741.6	100590.8	104691.6
RD_New_FArea_Res_400_Area	113226.8	130310	158183.6
RD_New_FArea_Res_800_Area	695676.8	759619.2	759619.2
RD_New_FArea_Res_1500_Area	3391015.2	3486476.4	3486476.4

Sub Total Business	2413032	1667830.4	2704642.4
Sub Total Residential	4298660.4	4476996.4	4508970.8
Total	**6711692.4**	**6144826.8**	**7213613.2**

	SIM1	Sim2	Sim3
Rate_Land_BUS200	$323,562	$352,977	$397,099
Rate_Land_BUS400	$1,091,312	$1,190,522	$1,339,337
Rate_Land_BUS800	$3,886,624	$4,033,289	$4,216,620
Rate_Land_BUS1500	$5,436,371	$5,596,264	$5,862,753
Rate_Land_Res200	$265,161	$270,573	$284,101
Rate_Land_Res400	$734,992	$769,991	$839,990
Rate_Land_Res800	$3,729,458	$3,907,051	$3,907,051
Rate_Land_Res1500	$12,499,605	$12,744,695	$12,867,241

Sub Total Business	$10,737,869	$11,173,052	$11,815,809

$ NZD - Redevelopment Construction	SIM1	Sim2	Sim3
New_Const_cost_Bus_200_Area	$144,630,400	$149,984,000	$161,916,000
New_Const_cost_Bus_400_Area	$268,048,000	$298,905,600	$322,095,200
New_Const_cost_Bus_800_Area	$1,090,752,800	$286,200,800	$1,161,116,000
New_Const_cost_Bus_1500_Area	$909,600,800	$932,740,000	$1,059,515,200
New_Const_cost_Res_200_Area	$197,483,200	$201,181,600	$209,383,200
New_Const_cost_Res_400_Area	$226,453,600	$260,620,000	$316,367,200
New_Const_cost_Res_800_Area	$1,391,353,600	$1,519,238,400	$1,519,238,400
New_Const_cost_Res_1500_Area	$6,782,030,400	$6,972,952,800	$6,972,952,800

Sub Total Business	$2,413,032,000	$1,667,830,400	$2,704,642,400

Sub Total Residential	$17,229,216	$17,692,311	$17,898,384
Total	**$27,967,085**	**$28,865,362**	**$29,714,193**

Sub Total Residential	$8,597,320,800	$8,953,992,800	$9,017,941,600
Total	**$11,010,352,800**	**$10,621,823,200**	**$11,722,584,000**

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