University of Southern Queensland

Faculty of Health, Engineering and Sciences

An Accessibility Investigation of the Gold Coast Light Rail System

A dissertation submitted by

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ABSTRACT

Increasingly in Australia there is a need for transport planners and policy makers to consider public transport accessibility to promote a physical shift from private motor vehicle reliance to more sustainable modes such as public transport and active transport. This shift is needed due to increasing problems associated with private motor vehicle use such as traffic congestion, rising greenhouse gas emissions, and decreased levels of physical fitness. With the implementation of the Gold Coast light rail, in operation since July 2014, an opportunity to undertake an investigation into the accessibility of stage one of this system exists. As such the aim of this research is to investigate the accessibility of the Gold Coast light rail system.

The methods used for this mixed methods research was an accessibility framework that was used to assess several key elements identified as important to physical accessibility. The social accessibility determined the travel cost and travel time using a mathematical formula. The integrated transport accessibility method was assessing the Gold Coast light rail with its integration with several other transport modes.

The research revealed that the physical accessibility of the Gold Coast light rail is currently high accessibility. However, improvements could be made to the bicycle facilities at the stations, on board and surrounding the station. The social accessibility revealed the potential affordability of the Gold Coast light rail. It was found that residents near a station it is not as affordable compared with the wider Gold Coast area. The integrated transport accessibility identified that the current system is accessible, however further improvements will increase this accessibility.

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Limitations of Use

Certification

I certify that the ideas, designs and experimental work, results, analyses and conclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

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CHAPTER 1

1.0 INTRODUCTION

'Shifting from private motorised vehicles to public transportation, walking and cycling can increase the sustainability of transportation and consequently, improve the environment, economics and public health' (Saghapour, Moridpour & Thompson 2016a). Accessibility has been identified as a measurement tool that can be used to increase public transport patronage (Yigitcanlar et al. 2007). Public transport accessibility can be defined as the ability for an individual to reach their desired destination from their origin through the use of public transport (Mavoa et al. 2012). Mavoa et al. (2012) categorises accessibility into three categories: access to public transport stations and stops; duration of public transport journey; and access to destinations using public transport. Accessibility is also critical to ensure those that are reliant upon public transport have equitable access to the network. As such, the focus for this research thesis is to investigate the accessibility of the Gold Coast light rail.

This chapter will begin by providing background to this research. It will then discuss the objectives, and justification for undertaking this thesis. An outline of this thesis will then be provided. Finally, it will summarise this chapter, and discuss briefly Chapter 2.

1.1 Background

The Gold Coast light rail is a thirteen kilometre network with sixteen stations extending from Gold Coast University Hospital station to Broadbeach South station (see Figure 1.1). This is a part of stage one which began operation in 2014 (GoldLinQ 2013). The light rail consists of a fleet of fourteen Bombardier Flexity 2 light rail vehicles with a carrying capacity of 309 patrons (GoldLinQ 2013).

Figure 1.1. Gold Coast Light Rail Map (GoldLinQ 2010).

A further second stage to the project is currently under construction with operation expected in early 2018 to coincide with the 2018 Commonwealth Games. This stage involves extending the current network to link with the heavy rail that services Brisbane, currently this is undertaken by way of feeder buses (Keys 2016). As seen in Figure 1.2 below, stage two will involve extending the line 7.8 kilometres from the existing Gold Coast University Hospital Station to Helensvale heavy rail station (Keys 2016).

Figure 1.2. Gold Coast light rail stage 2 extension to Helensvale shown in orange (GoldLinQ 2016).

A third stage has been proposed, however, further consultation and development is required. This stage would involve connecting the south Gold Coast by extending from the current Broadbeach South station down to Coolangatta (Keys 2016).

The light rail was first recommended in 2008 as a solution to Gold Coast's growing population and increasing traffic congestion problems (Keys 2016). The Gold Coast light rail is also seen as a fundamental piece of infrastructure for the 2018 Commonwealth Games to aid in the efficient transport of the expected attendees (GoldLinQ 2013). The light rail system is aimed at providing the Gold Coast with an integrated public transport system through linking with a network of feeder buses, and eventually the heavy rail (GoldLinQ 2013).

The level of accessibility of a public transport system has been identified as an important factor that has the ability to increase public transport patronage (Saghapour, Moridpour & Thompson 2016b). According to the 2011 Australian Bureau of Statistics (ABS) Census, on the Gold Coast approximately 72 per cent of employed individuals used private car as their method of travel to work (refer to Table 1.1 below) (Australia Bureau of Statistics 2017a). The data from the 2016 Census was not included as it was not yet released. The Gold Coast City Council anticipates that, through an accessible and integrated public transport system, the patronage rates can improve (GoldLinQ 2013).

Table 1.1. Method of Travel to Work - 2011 Census Gold Coast Area (Australia Bureau of Statistics 2017a).

Method of Travel to Work	No. of People	Percentage
Train/Tram	2,277	0.96%
Bus	4,064	1.7%
Car	172,361	72.5%
Motorbike/Scooter	1,851	0.78%
Bicycle	2,076	0.87%
Other (inc. Taxis)	4,438	1.9%
Walked only	6,727	2.8%
Used more than one method	4,446	1.9%
Other - Worked from home	13,149	5.5%
Other - Employed but did not go to work	23,086	9.7%
Other - Method of travel not stated	3,213	1.4%
Total	237,688	100.0%

Research into accessibility has found that a highly accessible public transport system is going to be more sustainable. This influences whether people do or do not use the public transport system (Saghapour et al. 2016b). This improved sustainability can reduce traffic congestion by moving a large number of people over significant areas (Saghapour et al. 2016b). A sustainable system is also one that provides equitable access to those with the highest need for public transport, whether it be through low pricing, higher provision, or services that support these individuals. It is anticipated that the Gold Coast light rail will provide a viable transport mode for both residents and tourists (GoldLinQ 2013). Therefore, it is important for the Gold Coast light rail to be planned and managed in a way which promotes and maximises public transport patronage through providing equitable accessibility to the system.

1.2 Aims and Objectives

The aim of this research is to investigate the accessibility of the Gold Coast light rail system. In order to investigate the accessibility of the Gold Coast light rail, this thesis has several objectives, which define what this thesis is aiming to achieve. The intention of this research was to determine the accessibility of the Gold Coast light rail, this includes:

- reviewing the literature;
- defining and developing an accessibility framework;
- data collection;
- measure the accessibility of the stations; and
- summarise the findings.

The first objective of this research was to undertake an assessment of the Gold Coast light rail system to determine its level of physical accessibility. This will involve the collection of data at three of the existing sixteen stations of the Gold Coast light rail, including, Gold Coast University Hospital Station, Southport Station, and Cavill Avenue Station.

The second objective was to identify the integration of the Gold Coast light with other forms of transport. For this objective the data collection will be undertaken in the same manner as the physical accessibility objective, at only three of the sixteen stations.

The final objective is to evaluate the social accessibility of the Gold Coast light rail system, specifically, the travel cost and time. By understanding the social accessibility, it will further expose another aspect on the accessibility of the Gold Coast light rail. This is particularly important, as those with the highest need are often in the lower socio-economic demographic. Therefore, understanding its affordability, and travel time, can potentially identify issues, or allow for lessons to be learnt that can be applied to future developments.

The literature review revealed that by improving the accessibility of a public transport system it promotes increased ridership, and improves the sustainability of the system. It also has the added benefit of promoting higher levels of physical activity that meet the minimum daily requirement for Australians. Through having a highly accessible public transport system, it leads to reduced car usage, and reduced traffic congestion.

1.3 Justification

Research has revealed that public transport use has the ability to counter the problems associated with private car use, including reduced traffic congestion, reduced greenhouse gas emissions, increased social interaction, and improved physical health (Mavoa et al. 2012; Saghapour et al. 2016a). In recent years transport planners and policy makers have focussed on increasing public transport patronage whilst decreasing private car use (Curtis & Scheurer 2017).

The literature has revealed that an important factor to increasing public transport patronage is through having a highly accessible system (Mavoa et al. 2012). An accessible public transport system must provide its' users with an easy means of reaching their desired destination, not only destinations of work but social and recreational destinations, within an acceptable time (Flamm, Sutula & Meenar 2014). It is also important to ensure that these systems are provided in a way which is socially equitable. That is the system provides the highest provision in areas with the highest needs. These include those of low socio-economic status, disabled, elderly, and students (Mavoa et al. 2012).

The Gold Coast light rail was implemented to provide residents and tourists with a public transport system to manage the increasing road congestion (GoldLinQ 2013). The first stage of the Gold Coast light rail has been in operation since 2014 but there has been no research undertaken to understand whether residents within the region are able to access the system effectively. This research has the potential to allow transport planners and policy makers to use the research on future stages and light rail projects to ensure these systems are highly accessible.

Through the data collection, both physical and social accessibility elements were considered. This was to allow for completeness as part of the data collection. Through this, it is anticipated that the results can identify areas where accessibility could be improved. But also identify elements of accessibility that the Gold Coast light rail performs exceptionally. The aim of this research was to undertake data collection to provide constructive suggestions that are unbiased. This research is prepared to allow for the identification of areas that need improvement, or could be used as a basis for future public transport systems.

This research has the potential to improve or be a basis for future planning, to contribute to the public transport accessibility. This could lead to improvements which relate to increased patronage, decreased car reliance and reduced traffic congestion, affordable and timely public transport, and improved health.

1.4 Outline

The thesis begins with an introduction in the first chapter. It provides a background to the thesis, identifies the aim and objectives of the thesis, and the thesis justification.

Chapter 2 reviews the literature, including a discussion on defining public transport accessibility and different methods to assess accessibility. The chapter includes a discussion on the benefits of a light rail system, and reviews different light rail networks in Australia. Finally, the chapter concludes with the history of the Gold Coast and its’ light rail network.

Chapter 3 discusses the methodology of this research, including the methods used, and resources required. This chapter includes justification for the choice of case study, the sampling strategy, and stations selected. It will also discuss the method for data collection, and how the data will be analysed.

Chapter 4 presents the results from the data collected and includes the data analysis of these results. With Chapter 5 being the discussion on the results from the data collection, as well as recommendations as a result of this research. Chapter 6 summarises the thesis, and concludes with recommendations for future research as well as for policymakers and transport planners.

1.5 Conclusion

The aim of this thesis is to investigate the accessibility of the Gold Coast light rail system. This is determined through using an accessibility measurement framework to assess the accessibility of three light rail stations as part of the Gold Coast light rail.

In this chapter, it has provided a background to the research, identified the research aim and objectives. It has given justification for undertaking this research, and an outline of the chapters in this thesis.

The next chapter will be a review of the literature relating to public transport accessibility, and light rail networks, with a focus on the Gold Coast light rail network.

CHAPTER 2

The purpose of a literature review is to gain an understanding on a topic, which includes what has been done previously, how the topic has been researched, and what are the main issues This literature review will identify the main theories of public transport accessibility, how these have been applied and developed, and criticisms relating to the research (Hart 1998). The purpose of a literature review is therefore two-fold: one to allow the researcher to gain a thorough understanding of the topic, and secondly to allow the audience to gain an understanding of the topic, its history, criticisms, and current debate (Hart 1998).

2.0 LITERATURE REVIEW

2.1 Introduction

For this thesis, it was necessary to carry out a literature review to aid in investigating the accessibility of the Gold Coast Light Rail.

The first section of the chapter defines public transport accessibility, and identifies the importance of investigating a public transport systems' accessibility to determine how a public transport system is performing. The chapter then goes on to identify the different frameworks used to evaluate the accessibility of a public transport system as well as identifying the different means to categorise measures of public transport accessibility.

This chapter will then investigate the benefits and disadvantages of having a light rail network with examples of global light rail systems. The chapter will then review the measured accessibility of light rail systems in Australia.

The chapter will review the history of the Gold Coast, and the current demographics of the area. This chapter will conclude with an analysis of the Gold Coast Light Rail, specifically, the need for it, its technical details, and finally the future plans for the Gold Coast Light Rail.

2.2 Public Transport Accessibility

For the purposes of this research, it is important to define what is meant by 'accessibility'. According to Hawas, Hassan, and Abulibdeh (2016), public transport accessibility can have a variety of meanings. Yigitcanlar et al. (2007) defined accessibility as the ability for an individual to reach desired opportunities which comprises foods, services, activities and destinations. Similarly, El-Geneidy et al. (2016) suggested accessibility is a measure of potential opportunities that are accessible from a particular location within a particular travel time or distance when using a certain travel mode. Mavoa et al. (2012) described accessibility as the ease to which an individual can access destinations at one location from another by a specific travel mode.

2.2.1 The Importance of Public Transport Accessibility

The accessibility of public transport in evaluating and planning has been identified as being important to allow individuals to socialise with others, partake in activities, which reduces social exclusion (Lättman, Olsson & Friman 2016). It has also been suggested that public transport accessibility is important to encourage a transport mode shift to reduce car reliance, and is critical for the welfare of non-car individuals, such as the elderly, youth, and disabled (Mavoa et al. 2012).

It has been suggested that having poor public transport accessibility can lead to social exclusion, as those most disadvantaged being unable to access public transport due to various barriers (Saghapour et al. 2016a). These barriers include distance, cost, poor access to stations and stops, and lack of services (El-Geneidy et al. 2016; Hawas, Hassan & Abulibdeh 2016; Mavoa et al. 2012; Saghapour et al. 2016a). There is also the issue of many transport systems having a pattern of high need but low provision (Fransen et al. 2015). That is those with the highest need of public transport services have the lowest provision of services that is often poorly accessible (Fransen et al. 2015). In particular, many suburban areas are characterised by significant gaps in public transport (Fransen et al. 2015). Research into social equity access to public transport found that the low salary and socially underprivileged individuals who are most likely to be public transport reliant often have the greatest barriers to public transport (El-Geneidy et al. 2016).

Furthermore, research into socially equitable access of public transport for residents has found that not all residents benefit from the same levels of accessibility (El-Geneidy et al. 2016). This has been suggested to be a result of the central and peripheral nature of cities (El-Geneidy et al. 2016).

Recent research into public transport accessibility has found that levels of ridership is dependent upon a systems ability to be accessible (Geurs, La Paix & Van Weperen 2016). Saghapour, Moridpour, and Thompson (2016b) in their study on public transport access found that areas with higher levels of public transport accessibility were positively associated with increased public transport patronage. Increasing public transport accessibility leads to an improvement of the sustainability of a transport system (Saghapour et al. 2016b).

Increasingly, transport policies and plans, and land use plans have been found to be critical in ensuring sustainable decisions are made in improving accessibility (Yigitcanlar et al. 2007). These plans have also included social equity as a long term objective (El-Geneidy et al. 2016). However, Curtis and Scheurer (2017) have suggested that accessibility is mainly absent from current planning evaluation. This leads to problems in improving the public transport system to increase accessibility and provide an alternative to car reliance (Curtis & Scheurer 2017).

2.2.2 Physical Accessibility

In the management and planning of urban areas, it has been recognised that a key component is public transportation (Dadhich & Hanaoka 2012). Furthermore, the increasingly rapid growth of urban areas has led to cities being required to provide public transport that is both sustainable and efficient (Dadhich & Hanaoka 2012; Saghapour et al. 2016b). Additionally, it has been suggested that urban form influences both indirectly and directly the public transport accessibility in relation to potential riders and proximity to stations (Dadhich & Hanaoka

2012). According to Dadhich and Hanaoka (2012), if access to public transport is restricted by distance or barriers for either trip origin or destination, then it is improbable it will be used as a travel mode. Furthermore, if the transport service is unreliable and inefficient in terms of time, this also decreases the likelihood of public transport being used as a travel mode (Dadhich & Hanaoka 2012).

In measuring a public transport system's accessibility, and comparing that with benchmarks to ensure that it meets t future plans and policies, it is necessary that the particular city's context be considered (Curtis & Scheurer 2017). Context refers to whether a city is poly-centric or multi-centric, the land coverage and density, and topographical features. These features have the ability to influence the public transport network (Curtis & Scheurer 2017).

The need for increased plans and policies into transport has risen from cities experiencing increasing road congestion (Curtis & Scheurer 2017). It has also been recognised that public transport systems must be developed to provide a real alternative to car based travel (Curtis & Scheurer 2017). It has been identified that a public transport system provides a long-term sustainable solution to reducing the impacts of road congestion, whilst having the ability to move a large number of people over significant distances (Saghapour et al. 2016b). Public transport systems also have the ability to provide mobility to those without access to cars (Saghapour et al. 2016b, 2016a). Also, public transport accessibility is important as the excessive levels of car based travel and car reliance can have negative consequences on both physical health and the environment (Mavoa et al. 2012; Saghapour et al. 2016a). These consequences include rising Green House Gas emissions, traffic congestion, oil price vulnerability, and the disorders and conditions from the detrimental effects of physical inactivity and obesity (Mavoa et al. 2012; Saghapour et al. 2016b, 2016a). Moving from a predominantly private vehicle travel mode towards public transport has the potential to increase public transport sustainability (Saghapour et al. 2016a).

The importance of public transport accessibility is the impacts it has upon a city's level of mobility (Saghapour et al. 2016b, 2016a). Furthermore, public transport is often considered a more social means of transport (Saghapour et al. 2016b). This results in cities increasing their liveability and sustainability (Saghapour et al. 2016b). To create a mobile public transport system that is efficient and sustainable for a city, it must consider the accessibility of the system (Saghapour et al. 2016a). This includes factors such as access to stops and stations, the mobility of a system, and integration to other transport modes (Saghapour et al. 2016a).

2.2.3 Public Transport Accessibility and Walkability

Research into public transport accessibility has identified the importance of walkability for the surrounding area. This surrounding area is generally defined as the acceptable walking distance (Vandebona & Tsukaguchi 2013). This distance is generally identified as the maximum distance a resident in the area is willing to walk to a public transport stop or station (Mavoa et al. 2012; Saghapour et al. 2016b; Vandebona & Tsukaguchi 2013). Dadhich and Hanaoka (2012) identified distance to public transport stops/stations as one of the main barriers that prevent people from having good accessibility. Saghapour, Moridpour, and Thompson (2016), identified Australia's suburban and regional areas are disadvantaged in terms of public transport accessibility as distance to stops/stations is a major barrier. It also results in the private car being favoured as the mode of travel compared with public transport (Dadhich & Hanaoka 2012). Most research uses the average walking distance as 400 metres to bus stops and 800 metres to train stations (Hawas et al. 2016; Mavoa et al. 2012; Saghapour et al. 2016b; Vandebona & Tsukaguchi 2013). It has also been suggested that the median distance people are willing to walk to public transport stops/stations, is greater from the origin than it is for the end destination, with people willing to walk 600 metres and 470 metres, respectively (Mavoa et al. 2012). Furthermore, it is evident the average distances people are willing to walk, is greater than the commonly used value of 400 metres to public transport stops or stations (Mavoa et al. 2012).

2.2.4 Public Transport Accessibility and Bicycle Access

Related to the walkability of the area surrounding a public transport stop/station is the bicycle access. Integrating public transport with bicycling promotes the use of public transport and bicycling as modes of travel (Geurs et al. 2016). Geurs, La Paix, and Van Weperen (2016) found that enhancing the quality of bicycle routes can markedly improve train ridership, and the possible employment accessibility of train users. It was also found that improvements to bicycle and train integration policies were more beneficial for medium and large stations. At the same time, it was better to improve the train's level of service for small stations (Geurs et al. 2016). It was also acknowledged that the perceived quality of stations and bicycle routes were important to the level of ridership (Geurs et al. 2016).

Bicycles are also important to consider in public transport accessibility, as bicycles allow for a larger catchment area that walking does not allow (Flamm et al. 2014; Geurs et al. 2016). This catchment area increases on average to 3.2 kilometres to 5.3 kilometres a bicycle rider will travel from the public transport stop/station (Flamm et al. 2014). Furthermore, the economic benefits of bicycling to public transport stops are reflective in lower costs of park-and-ride facilities for cars and public transport (Flamm et al. 2014; Geurs et al. 2016).

2.2.5 Social Accessibility

It has been identified that improving public transport accessibility leads to improving the populations health (Barr et al. 2016). This health improvement is a result of increased levels of physical activity through walking more (Barr et al. 2016). A positive association exists between higher levels of public transport accessibility and a walking time of more than the recommended 150 minutes per week (Barr et al. 2016; Djurhuus et al. 2014). Djurhuus et al. (2014) found that public transport users accumulate higher levels of moderate physical activity than those who do not use public transport. Furthermore, health improvements are associated with higher levels of public transport use through a reduced reliance on cars. This is due to the motor vehicle not facilitating human movement (Barr et al. 2016). In terms of the public health perspective, understanding how the accessibility of public transport is associated with active commuting is important (Djurhuus et al. 2014). Measures important include distance to transit stop, density of stops, and number of transport modes.

An important social aspect to improving public transport accessibility is the equitable access to the public transport system (Mavoa et al. 2012). In particular, access for those individuals with a disability, particularly for those that are disabled, wheelchair bound, and blind (DWB) commuters (Zhou et al. 2012). Zhou et al. (2012) suggested that traditional public transport systems generally are unable to provide effective access for those individuals with a disability. Furthermore, it is suggested that public transport systems are designed for a healthy individual without considering the needs of those with a disability (Zhou et al. 2012). Results of surveys conducted also indicate that to improve the quality of life for those individuals with a disability, the accessibility of public transport systems need to be improved, and made more attractive (Zhou et al. 2012). It has also been found that in developed countries the public transport accessibility does not meet the needs of individuals with disabilities (Zhou et al. 2012).

2.2.6 Public Transport Accessibility and Disabled Access

Ferrari et al. (2013) found that information important for those individuals with a disability is often not included in public transport journey planners. Therefore, this constrains the individual with a disability from using public transport (Ferrari et al. 2013). This is important to consider in accessibility as those with a wheelchair require prior knowledge that vehicles and stations are wheelchair accessible (Ferrari et al. 2013). These constraints include the issue of pavement to vehicle gap, for which the European Union standard is less than five centimetres (Zhou et al. 2012).

2.3 Public Transport Accessibility Frameworks

Research into public transport accessibility generally categorises accessibility measures into three categories:

1) Access to transport stops,
2) Duration of public transport journey, and
3) Access to destinations via public transport (Mavoa et al. 2012).

Within these three broad categories, several researchers provide more specific measures of transport accessibility.

2.3.1 Types of Measures

Hawas, Hassan, and Abulibdeh (2016), identified transport accessibility as having three elements. These are:

1) Trip coverage,
2) Spatial coverage, and
3) Temporal coverage (Hawas et al. 2016).

Saghapour, Moridpour, and Thompson (2016) suggest that measures of public transport accessibility can be categorised into six main categories, including:

1) Travel time and distance: measures the physical access to public transport stops and stations,
2) Travel times and costs: this measures an individual's ability to reach their destination by accounting for the travel time or cost in the public transport network,
3) Integral accessibility: measures the overall access associated with a number of potential destinations. That is, it measures the general access of distance and time to a destination for a specific activity,
4) Time geography: measures a travellers' movement over space whilst their activity choice is dependent upon time,
5) Utility Theory: commuters are deemed as customers and public transport modes are as a travel preference set, and

6) Relative accessibility: presumes that a travellers mode of travel is a result of cost, time, convenience, and safety (Saghapour et al. 2016a).

Geurs, La Paix, and Van Weperen (2016), used four groups to distinguish between accessibility measures., this includes:

1. Infrastructure based measures which analyse the performance and level of service for public transport network infrastructure. Infrastructure based measures can investigate travel time, network connectivity;
2. Location accessibility measures comprise the second group, which analyses the access to a range of activities and nodes;
3. Person based accessibility measure, which accounts for individual limitations such as disability, and determines the level of accessibility; and
4. Utility based accessibility which investigates the wellbeing aspects of accessibility levels to a variety of activities and nodes (Geurs et al. 2016).

It is also suggested that a recent measure could be considered the fifth group which is perceived accessibility measures (Geurs et al. 2016). This considers the number of activities or nodes that are accessible opportunities. This conflicts with the location and utility based measures which assumes that all activities or nodes are accessible (Geurs et al. 2016).

2.3.2 Measurement Frameworks

Research into public transport accessibility often involves the researchers developing their own framework. Most frameworks are Geographic Information Systems (GIS) based (Saghapour et al. 2016a). The development of these new accessibility frameworks is argued to assist in decision making (Curtis & Scheurer 2016). Based on a review of the literature it was found that there is no agreed standard regarding acceptable levels of public transport accessibility.

A relatively recent accessibility measure is the Spatial Network Analysis for Multimodal Urban Transport Systems (SNAMUTS) (Curtis & Scheurer 2017). The main purpose of the SNAMUTS tool was to allow those who seek to improve public transport accessibility to find the answers to these questions (Curtis & Scheurer 2016). More specifically, it attempts to be a visualisation and identification tool of a public transport system's strength and weaknesses, to connect places of activity efficiently, show the strategic significance of the routes and network nodes, as well as the network's resilience to future patronage increase, and illustrate a trip planners flexibility in utilising the system for both planned and unplanned trips (Curtis & Scheurer 2017). The SNAMUTS tool has been developed based on the aforementioned aspects (Curtis & Scheurer 2017). A beneficial element of the SNAMUTS tool is that it has been designed for comparison between multiple cities (Curtis & Scheurer 2016). This measurement tool is the most applicable to the Gold Coast light rail as it is within the Australian context and based upon Australian case studies.

The SNAMUTS tool uses several indicators to assess the accessibility of a city's public transport system (Curtis & Scheurer 2016). These indicators include:

- Service Intensity: this is the number of operational public transport vehicles during a weekday peak period to calculate the intensity relative to the population (for example, 100,000 residents) (Curtis & Scheurer 2016).
- Closeness Centrality: this is focused on the ease of movements across a public transport system based on the speed and service frequency factors (Curtis & Scheurer 2017).
- Degree Centrality: this indicator determines the degree of separation between nodes of activity. This is measured by counting the number of transfers that are required by a traveller between two activity nodes (Curtis & Scheurer 2017).
- Network Coverage: this is focussed on determining those with and without walkable access to public transport (Curtis & Scheurer 2016). This uses land-use patterns to determine areas where minimum service standards are met. This is

measured through identifying the percentage of residents and employment that is located with the defined walking distance of stops and stations (800 metres for rail and ferry stations, and 400 metres of tram, and bus stops) (Curtis & Scheurer 2017).

- Thirty-Minute Contour Catchment: this is also a land-use measure that identifies the percentage of residents and jobs that are capable of being accessed within 30 minutes using public transport systems (Curtis & Scheurer 2017).
- Betweenness Centrality: this indicator measures the travel opportunities to nodes within a network and routes using geographical distribution. It also identifies a public transport networks' service levels and configuration (Curtis & Scheurer 2017).
- Segmental and Network Resilience: this indicator identifies the ability for a network to facilitate increased patronage growth. This is through a ratio of route segment betweenness and level of service based on capacity (Curtis & Scheurer 2016, 2017). This indicator is identifying if and how a public transport network is future proof (Curtis & Scheurer 2016).
- Nodal Connectivity: this measures a patrons' flexibility to move throughout the city using the public transport system, and the different activity nodes' strength. This is done through determining travel opportunities per hour, for different nodes and in various directions (Curtis & Scheurer 2016).
- SNAMUTS Composite Index: this indicator is a collective of the above indicators, into a comprehensive visualisation to determine overall accessibility. This indicator is beneficial for multiple city comparisons (Curtis & Scheurer 2016).

Another accessibility framework is the Land Use and Public Transport Accessibility Index (LUPTAI) (Yigitcanlar et al. 2007). This measures a public transport systems' ability to access common Land Use Destinations (LUD) including health, educational facilities, retail, and employment (Yigitcanlar et al. 2007). The LUPTAI measurement tool integrates walking distances, public transport travel time and service frequencies to calculate accessibility (Mavoa et al. 2012). The main point of difference of the LUPTAI to other accessibility measures is that the indices are allocated to grid cells for outcome indices (Mavoa et al. 2012). The LUPTAI measure determines the accessibility of public transport system based on walkability. It specifically identifies the distance to be travelled to reach common LUD, as well as considering the travel time and service frequency (Yigitcanlar et al. 2007).

Hawas, Hassan, and Abulibdeh (2016) developed a framework based upon Multi-Attribute Utility Theory (MAUT) to determine the accessibility of a public transport system. MAUT is based upon the broader Multi-Criteria Decision Making field. A MAUT approach can be defined as a structured methodology which has been aimed to manage the trade-offs among multiple objectives (Hawas et al. 2016). The MAUT also has the ability to rank the different indicators in order of preferences, and quantify these indicators (Hawas et al. 2016). In their study, Hawas, Hassan, and Abulibdeh (2016), used the Technique of Order Preference by Similarity to Ideal Solution (TOPIS) for their methodology. TOPIS uses either individual or aggregate criterion scores to compare it with different options (Hawas et al. 2016). The result from a TOPIS assessment is providing an ideal solution that is considered the best (Hawas et al. 2016). In developing the TOPIS, a staged methodology was proposed which identified key steps in developing the proposed TOPIS methodology. This process is identified in Figure 2. (Hawas et al. 2016). The criteria used for the study were transit coverage, supply, and route diversity. Within these criteria are several indicators, as follows:

- Transit Coverage: indicators include population of a defined area, total land cover in defined area,
- Supply: indicators include passenger trips per hour and per capita, transit stops per capita and land area, and
- Route Diversity: these indicators are access to different destinations from origin points using public transport systems, and availability of the transit system.

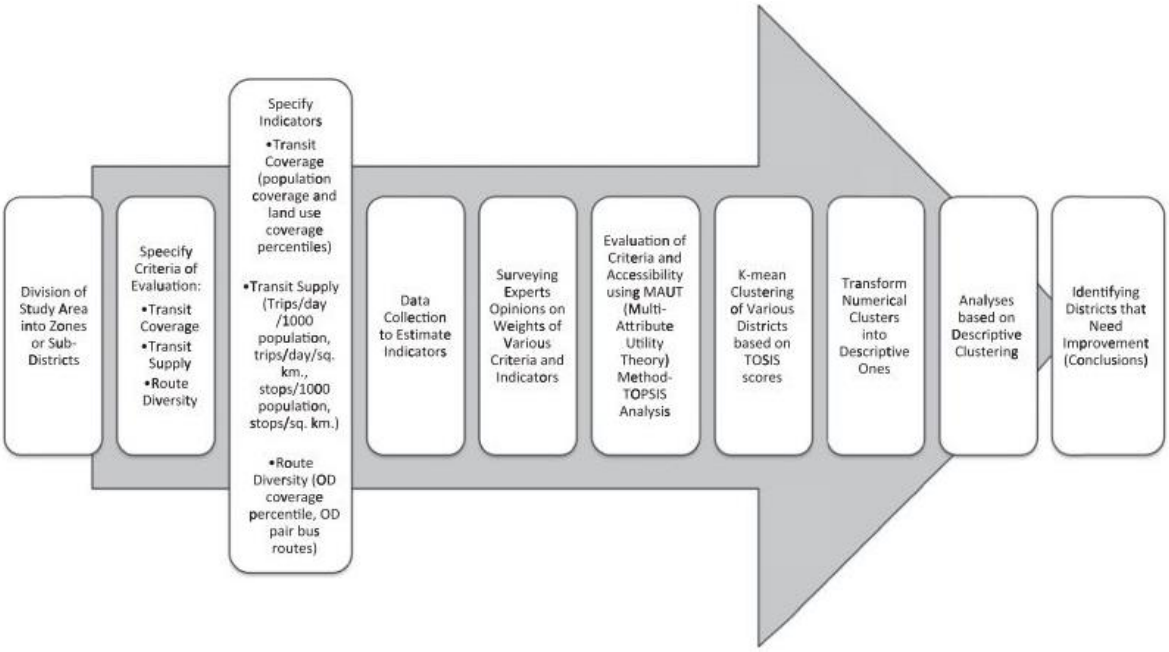

Figure 2.3. Proposed methodology staging for TOPIS accessibility framework (Hawas et al. 2016).

These indicators have been developed based upon two broad categories of transit service performance (Hawas et al. 2016; Meyer 2000). These indicators are general performance indicators, and effectiveness indicators (Hawas et al. 2016; Meyer 2000). The general performance indicators assess the overall performance of a public transport system. These generally include factors such as service area population and size, passenger trips, and vehicle availability for maximum and minimum service (Meyer 2000). The effectiveness indicators identify the extent to which the service standard of the system is met. This includes indicators such as service supply, passenger trips per capita, availability including hours of operation (Meyer 2000). Using the indicators, the TOPIS is used to assess the different areas of the public transport system using GIS analysis. This analysis is then used to identify areas in which improvement is needed (Hawas et al. 2016).

The Public Transport Accessibility Index (PTAI) was developed by Saghapour, Moridpour, and Thompson (2016) as a measure to assess Melbourne’s accessibility level , specifically to assess the public transport network in Melbourne’s 9510 statistical areas level 1 (SA1)

(Saghapour et al. 2016b). This index used GIS modelling to develop a model that identifies service coverage of the public transport network (Saghapour et al. 2016a). The PTAI tool follows an approach to determine Melbourne's level of accessibility (Saghapour et al. 2016b, 2016a). The PTAI defines the public transport system by identifying stations and stops, as well as modes of transport. In the case of Melbourne the modes are buses, trains and trams (Saghapour et al. 2016b, 2016a). The service frequency of the system is determined by using the timetable for each mode in the morning peak hour from 7:00 to 9:00 (Saghapour et al. 2016b). Another element that is identified is the Points of Interest using a database from the Australian Urban Research Infrastructure Network (AURIN). The points of interest include urban centres, landmarks, public and community spaces and facilities, and educational centres (Saghapour et al. 2016b).

The PTAI identifies geographical areas based on Australian Bureau of Statistics (ABS) statistical areas for Melbourne. These areas are then used to identify total residential population and number of dwellings in an area (Saghapour et al. 2016b). Another element is to identify characteristics relating to demographics, car ownership rates, and trip information for Melbourne using the Victorian Integrated Survey of Travel and Activity (VISTA) (Saghapour et al. 2016b). The PTAI identifies the walk time from Points of Interests to public transport stops and stations to identify accessibility from these points (Saghapour et al. 2016b, 2016a). The PTAI then requires several mathematical calculations to determine accessibility. The average waiting time at a station, the total access time, equivalent frequency which determines availability of public transport to a point of interest, weighted equivalent frequency (WEF), and population density are the mathematical calculations (Saghapour et al. 2016b, 2016a). Using the above calculations and data, the PTAI is then calculated to determine the level of accessibility based on spatial coverage (Saghapour et al. 2016b, 2016a). In Figure 2.4 it identifies the conceptual framework to determine the level of public transport accessibility for a particular public transport system (Saghapour et al. 2016a).

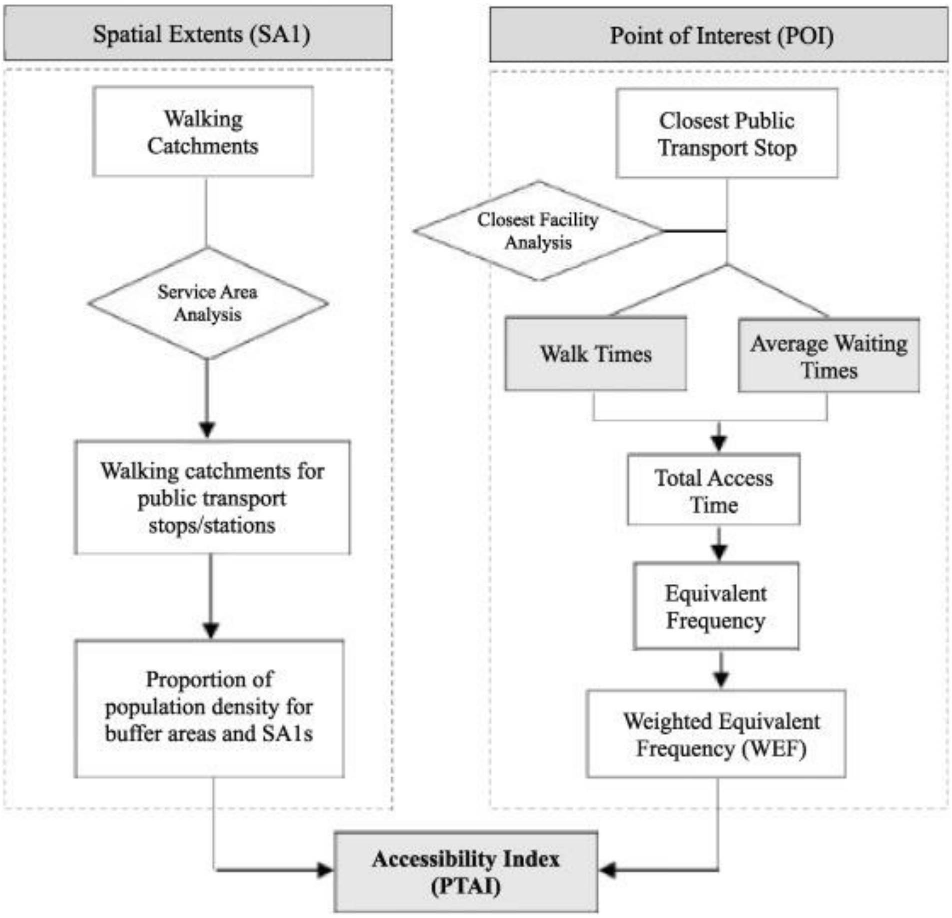

Figure 2.4. Conceptual framework for PTAI calculation process (Saghapour et al. 2016a).

The Public Transport and Walking Access Index (PTWAI) was developed to determine the range of destinations that are accessible when an individual's modes of travel are restricted to walking and using public transport (Mavoa et al. 2012). Using the PTWAI it determines level of accessibility to a variety of land use destinations including education, financial, health, shopping, social and recreational (Mavoa et al. 2012). This accessibility is determined through travel time, which also includes a ten minute wait time at public transit stops when there was a change in the mode or route of transport (Mavoa et al. 2012). This wait time was calculated based on the seven minute average arrival wait time for public transit users in New Zealand (Lester & Walton 2010). To calculate public transit frequency, the service frequency based on a schedule was used, with the frequency at each stop being the number trips for an full day (Mavoa et al. 2012). To determine level of accessibility, a weighting score system was used based on travel time in minutes, as seen in Table 2.2 (Mavoa et al. 2012).

Table 2.2. PTWAI weighted score system (Mavoa et al. 2012).

PTWAI score	Label	Description
0–4	Very low	Accessible within a travel time >60 min on average
5–8	Low	Accessible within a travel time between 40–60 min on average
9–12	Medium	Accessible within a travel time between 20 and 40 min on average
13–16	High	Accessible within a travel time between 10 and 20 min on average
17–20	Very high	Accessible within a travel time <10 min on average

There are several other public transport accessibility frameworks found as part of a review of the literature, which are briefly discussed below:

- Dutch National Transport Model (NVM): this model considers several elements and determines the effect changing elements of the public transport network has on levels of accessibility (Geurs et al. 2016).
- Index of Public Transport Needs (IPTN) and Index of Public Transport Provision (IPTP): a weighting system framework which aimed at identifying the gaps in a public transport system through comparing the needs and provision of a system (Fransen et al. 2015). This framework is able to determine the social accessibility of a public transport system (Fransen et al. 2015).
- Analysis of demand of public transport currently and predicted in the future. This accessibility measure determines coverage areas of the public transport network as well as the demand for the public transport. This can assist in future planning of a public transport system (Dadhich & Hanaoka 2012).

El-Geneidy et al. (2016) proposed an accessibility measure that includes travel time and travel fares. These measures are used to determine if the level of public transport accessibility between those in socially disadvantaged neighbourhoods is the same as those in other neighbourhoods (El-Geneidy et al. 2016). To determine accessibility based on travel time and travel cost, two different means of expressing this were provided including expressed as cost, and expressed as time. To determine accessibility based upon travel time and travel cost in monetary terms, is shown in equation (2.1)

$$C_{ij} = t_{ij}w + F_{ij} \tag{2.1}$$

Where

C_{ij} is the time cost of travel

t_{ij} is the travel time in hours

w is the minimum wage per hour

F_{ij} is the transit fare

The second method to determine accessibility based upon travel time and travel cost is in time, which is identified in equation (2.2)

$$C_{ij} = t_{ij} + \frac{F_{ij}}{w} \tag{2.2}$$

Where

C_{ij} is the time cost of travel

t_{ij} is the travel time in hours

w is the minimum wage per hour

F_{ij} is the transit fare

This methodology allows for an accurate measure of accessibility to be simply conveyed from transport planners to policy makers (El-Geneidy et al. 2016).

2.4 Light Rail Systems and their Benefits

The recent resurgence of light rail systems is a result of cities requiring a solution to the ever-growing traffic congestion problems (Currie & De Gruyter 2016; Keys 2016; Wilkie & Peterson 2010). This is to allow cities to improve mobility within the Central Business District (CBD) (Wilkie & Peterson 2010). Light rail has been identified as a public transport system that is electrically powered, a contemporary tram system, to serve the urban centre and central suburban neighbourhoods (Ludlam 2010; Wilkie & Peterson 2010).

Light rail systems have been identified as a mode that rather than working in opposition to other modes of transport, complements a transport network (Wilkie & Peterson 2010).. The gaps that arise between bus and heavy rail can be filled with a light rail network given its carrying capacity (Wilkie & Peterson 2010). This reasoning is why light has been identified as being valuable in providing a variety of public transport options to users (Wilkie & Peterson 2010).

The implementation of light rail systems have increased in recent years as it is more advantageous over a bus system through the use of permanent infrastructure separated from other traffic, and light rail often being given right of way over other traffic (Keys 2016). The public perception of light rail is that it is reliable as the route is permanent (Wilkie & Peterson 2010). It is also supported within literature that public transport users have a psychological preference for light rail over buses (Keys 2016). When compared with heavy rail it is the more favourable option as it is often more affordable to implement and maintain, as well as being easier to integrate into a city (Keys 2016).

Incorporating a light rail network within an inner city area has been identified as a means of rejuvenating these areas (Currie & De Gruyter 2016; Wilkie & Peterson 2010). This extends to the redevelopment of both commercial and residential areas (Currie & Burke 2013). Light rail has been an incentive for urban renewal projects, thus increasing property values, and a means of stimulating economic activity within these inner city areas (Ludlam 2010). Furthermore, the infrastructure required for light rail has less of an impact on the urban environment than that of heavy rail (Ludlam 2010). This environmental impact is further lessened through a reduction in traffic congestion and reduced need for buses to operate within a busy and congested inner urban area (Currie & Burke 2013; Currie & De Gruyter 2016; Wilkie & Peterson 2010).

In terms of environmental benefits it is often seen as a more energy efficient and sustainable form of transport in comparison with other modes of transport (Wilkie & Peterson 2010). As light rail is electrically operated it allows for energy to be drawn from renewable sources (Ludlam 2010; Wilkie & Peterson 2010). Energy use per user per kilometre for light rail cities is 41 per cent less than those cities with bus systems (Ludlam 2010). This reduces the need for liquid fuels to operate transport, thus reducing the greenhouse gas emissions of a city through reduced car usage and a reduced number of buses needing fuel (Ludlam 2010; Wilkie & Peterson 2010). The emissions for those cities with light rail is reduced by 23 per cent per capita (Ludlam 2010). For example the Tenerife light rail network in Spain, and the Calgary light rail system in Canada, with both systems being powered exclusively from renewable energy sources (Wilkie & Peterson 2010).

Light rail has also been identified as a means of increasing public transport ridership (Currie & De Gruyter 2016). Light rail is also often more comfortable than buses, improving the liveability and amenity of a city as the areas surrounding the route are often renewed (Ludlam 2010; Wilkie & Peterson 2010). In addition, light rail is easier to integrate with pedestrian areas, and promotes walkability (Ludlam 2010; Wilkie & Peterson 2010). Users of light rail have been found to be more healthy through having better walking habits, reduced car usage, andreduced occurrence of obesity (Wilkie & Peterson 2010). Light rail users are also more confident with their system as the permanency means they know where the system will go, and that a tram will actually arrive (Ludlam 2010; Wilkie & Peterson 2010).

This permanency of a public transport mode gives an assurance to both users and investors (Wilkie & Peterson 2010). This is through confidence in knowing the route will not change, and allows for the perception that light rail systems provide better service quality when compared with buses and heavy rail. These benefits include dependability, amenity, lessened noise, and more space within the trams (Wilkie & Peterson 2010).

In addition, light rail systems have been identified as an attractor for tourists, and residents of an area (Wilkie & Peterson 2010). This is due to the iconic value that a good light rail system has, such as that of Melbourne (Wilkie & Peterson 2010). Light rail is also an attractor as it is easier for not only domestic and international tourists to navigate, but also for residents of the area. This is often a result of the routes being permanent, and much more visible (Wilkie & Peterson 2010). These factors lead to increased ridership of the network (Currie & De Gruyter 2016).

One of the major benefits of a light rail system is its carrying capacity, with an estimated capacity of 12,000 passengers per hour per direction (Currie & Burke 2013; Ludlam 2010; Wilkie & Peterson 2010). The carrying capacity of a light rail vehicle is one of the main benefits for several reasons. In terms of operating costs, it is reduced as it has the ability to transport more passengers than a bus is capable of, as well as having a greater service life expectancy being double that of buses (Wilkie & Peterson 2010). There are significant environmental benefits from having greater carrying capacity as there is a reduced need for as many buses to transport the same number of passengers, and a reduction in the number of cars used as a means of transport (Wilkie & Peterson 2010).

The most successful light rail system is that of Zurich, in Switzerland (Wilkie & Peterson 2010). This is due to the light rail system being able to meet the majority of the need for transport in Zurich, with 64 per cent (or 197.3 million passenger journeys) of public transit users using light rail (Wilkie & Peterson 2010). This is estimated to be 550 trips per capita each year, which is four times that of Australia's usage (Wilkie & Peterson 2010). This success is due to the transit priority program being implemented over the past thirty years, the dense urban form, and deterrent to use a private car (Wilkie & Peterson 2010).

Despite the many advantages of a light rail network there are disadvantages to implementing and maintaining a light rail network. The main disadvantage is the capital and operating costs associated with the projects. The capital costs of implementing a light rail system are considered to be highly sensitive to the amount of tunnelling, bridges, shared right-of-way's, and viaducts (Lesley 2011; Ludlam 2010). The estimated cost per kilometre of the Gold Coast Light Rail was estimated to be $92 million, for a 13 kilometre track at total project cost of $1.2 billion (GoldLinQ 2013). In comparison with other light rail networks globally, this is considered to be expensive, refer to Figure 2.5 below.

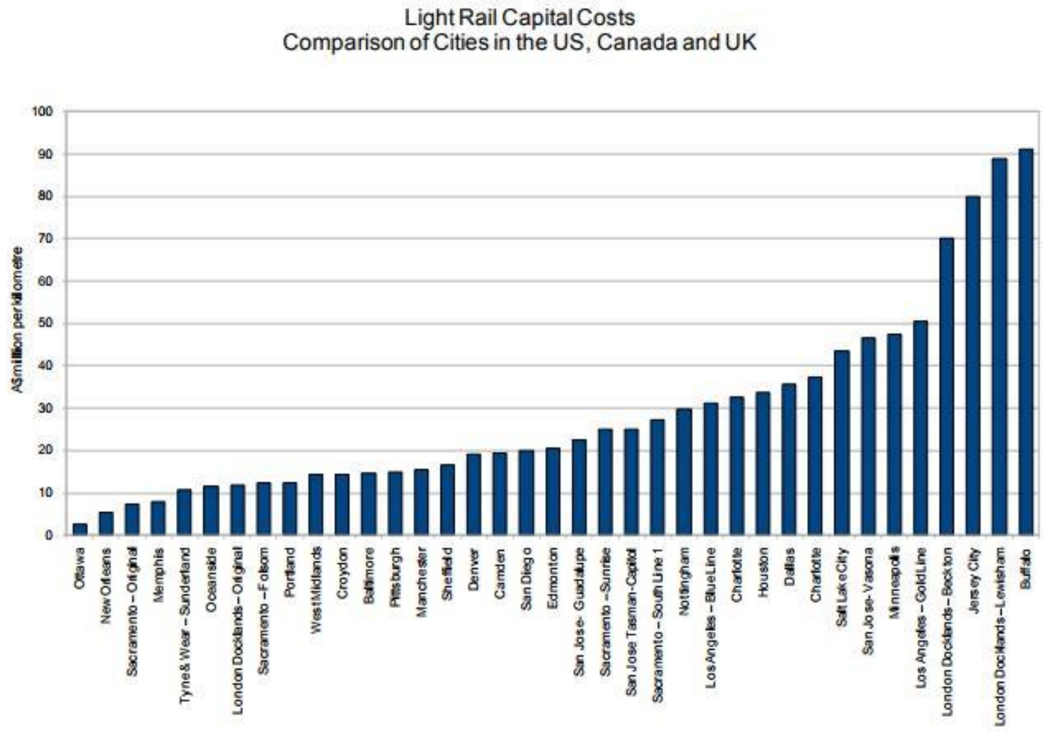

Figure 2.5. Light Rail Capital Costs globally comparison of costs per kilometre (Ludlam 2010).

With the capital costs, is the ongoing operating costs of the system. It is estimated that the estimated operating costs for the Gold Coast light rail are $700,000 per kilometre per annum (Ludlam 2010). The viability of the system is reliant upon the annual patronage of the network (Lesley 2011).

Another disadvantage of the light rail network relates to implementing segregated right-of-way's. In dense urban areas, that are well formed, this means buying back property from residents or using existing roads (Lesley 2011). This in turn leads to issues on the surrounding road network due to roads being closed permanently for the light rail system (Lesley 2011).

Often with segregated light rail systems, the stations and stops are in the centre of the road. This leads to safety issues of people having to cross roads just to access the light rail vehicles. Furthermore, in older systems, such as Melbourne, the trams boarding point is from the road surface and not a platform (Currie & Burke 2013). This leads to significant accessibility issues for those that are disabled (Currie & Burke 2013).

2.5 Light Rail Systems in Australia

Australia once boasted extensive light rail systems in every major city as well as in several regional centres during the gold rush and pre-war eras (Ludlam 2010). Many of these systems that once dominated these cities form of transport, were torn out in the post-war era when the rise of the motor car began (Ludlam 2010). These light rail networks were located in Melbourne, Sydney, Adelaide, Brisbane, Perth, Hobart, Kalgoorlie, Bendigo, Ballarat, and Leonora (Ludlam 2010). Melbourne, was the only Australian city to retain their system, which is now iconic globally (Ludlam 2010; Wilkie & Peterson 2010).

Currently in Australia, most major cities either already have a light rail network, have one under construction, or are considering the proposal (Keys 2016). The cities that currently have a light rail network include Melbourne, Sydney, Adelaide, Gold Coast, and Dulwich Hills (Keys 2016). Canberra, Hobart, Darwin, Parramatta, Newcastle, and a further expansion in Sydney, are either currently under consideration, or being constructed (Keys 2016).

Melbourne’s light rail network is identified as the largest network operating in the world, as displayed in Figure 2.6 (Currie & Burke 2013; Currie & De Gruyter 2016; Keys 2016; Ludlam 2010; Wilkie & Peterson 2010). It has an estimated 250 kilometres of track, 501 tram vehicles in the fleet, 30 routes, and approximately 1800 stops (Currie & Burke 2013; Currie & De Gruyter 2016; Keys 2016; Ludlam 2010; Wilkie & Peterson 2010). Trips taken by way of trams was estimated to have been 158.3 million in 2007 and 2008 (Ludlam 2010). Despite being the most extensive network globally, Melbourne’s light rail network is faced with problems. As it is the largest streetcar system in the world, it is also one of the slowest networks, being limited by average speeds of fifteen kilometres per hour, mostly due to traffic congestion (Currie & Burke 2013). Furthermore, it is noted to have significant safety and access issues associated with the tram network. Specifically these are an average of 45 accidents involving cars and pedestrians from the need to cross busy roads to access trams at approximately 1200 stops (Currie & Burke 2013). The Melbourne tram system is also faced with accessibility issues due to non-compliance and the inability to be accessed by those with a disability (Currie & Burke 2013; Wilkie & Peterson 2010). This is due to trams being accessed from the road surface as opposed to a platform (Currie & Burke 2013).

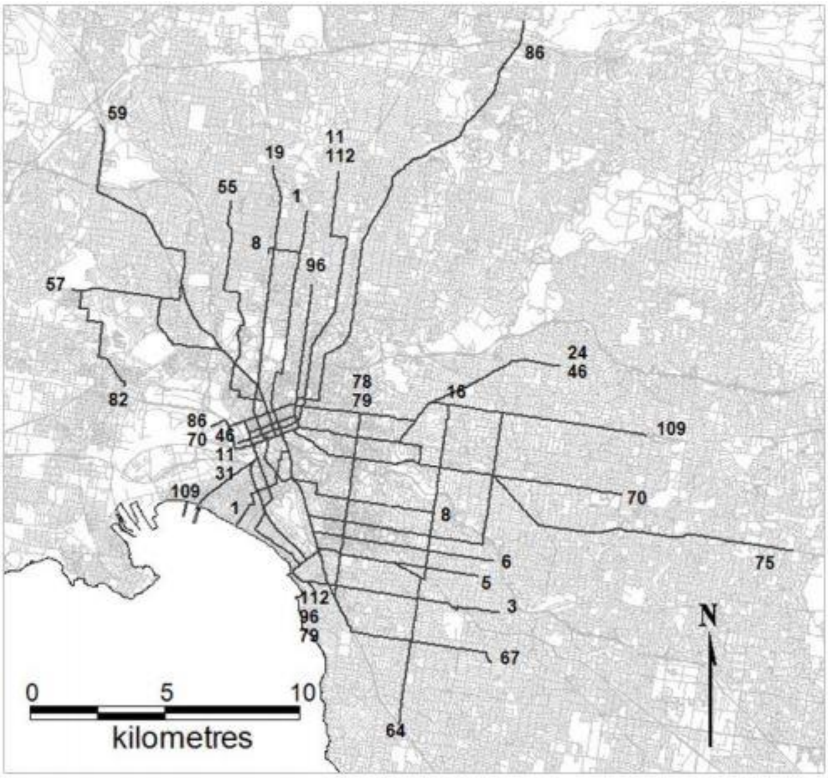

Figure 2.6. Melbourne's light rail network (Currie & Burke 2013).

Sydney which once boasted the largest tram network in Australia, reinstated their network in 1997; a 7.2 kilometre route which extended from Sydney's central station to Lilyfield (Ludlam 2010; Wilkie & Peterson 2010). This system, which was fully privatised, had fourteen stops and seven trams as part of its fleet (Currie & De Gruyter 2016; Ludlam 2010; Wilkie & Peterson 2010). In 2014, it was extended by 5.6 kilometres to Dulwich Hill, as shown in Figure 2.7 (Currie & Burke 2013; Keys 2016). The patronage for this system in 2014 to 2015 was 6.1

million trips (Keys 2016). Further extensions to this system, which extends the network twelve kilometres from Circular Quay to Randwick and Kingsford are currently under construction (Keys 2016). This extension was necessary given the future expected travel demand within inner Sydney (Keys 2016). Light rail was necessary to replace buses with light rail vehicles which have higher carrying capacities, to reduce congestion within inner Sydney (Keys 2016).

Figure 2.7. Sydney light rail network map (Currie & Burke 2013).

The Adelaide light rail network, similar to Sydney, is relatively small, in that it only operates on 12.4 kilometre tram line from the CBD extending to Glenelg (Currie & De Gruyter 2016; Ludlam 2010; Wilkie & Peterson 2010). The current network operates eleven light rail vehicles in the fleet, and covers 21 stops (Wilkie & Peterson 2010). As with many other cities, Adelaide once had a larger tram system that covered the entire metro area, that closed in 1958 (Ludlam 2010). Further investigation to extending the current network, as seen in Figure 2.8, are currently being proposed (Currie & Burke 2013; Keys 2016).

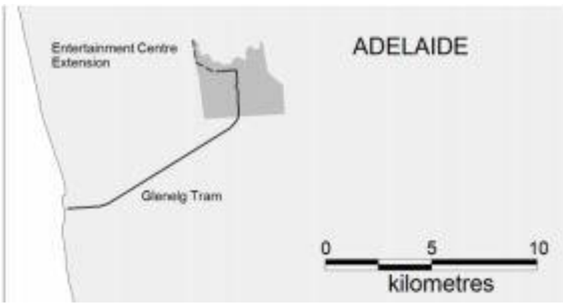

Figure 2.8. Adelaide light rail system map (Currie & Burke 2013).

Canberra is currently in the phase of constructing a light rail route that extends from Gungahlin to Canberra's centre, in total twelve kilometres in length with thirteen stops (Keys 2016). This network is expected to begin operation in 2019 (Keys 2016). Estimations on future usage is an expected 15,120 daily ridership generated in 2021, totalling 4.7 million trips per year (Keys 2016). Further extensions to this are proposed in future stages, with up to an additional six light rail routes, with the total length of this network being approximately eighty kilometres (Keys 2016).

Parramatta – in Sydney – has proposed a twenty kilometre light rail network consisting of three routes, with operations to begin in 2019 (Keys 2016). This light rail network will involve converting the Carlingford heavy rail line to light rail, and the construction of a line from Westmead Hospital via Sydney Olympic Park to Strathfield (Keys 2016). The reasoning for implementing this light rail network was to further establish Sydney's second CBD at Parramatta, promote development, better linking people and places, and giving commuters another mode of transport (Keys 2016).

In 2018, Newcastle is expected to begin operation of a 2.7 kilometre light rail network, currently under construction, with six stops extending from Wickham Interchange through the CBD to Pacific Park (Keys 2016). The need for this light rail network was as a replacement to the heavy rail service which ceased operation in 2012 (Keys 2016). As well as being a means of redeveloping the CBD in Newcastle, and boost the economy (Keys 2016).

Investigations into light rail have been carried out by the Tasmanian government that would operate between Hobart's inner city and extend to the northern suburbs of Granton and Glenorchy (Keys 2016). Similar to Tasmania is Darwin, with provisions for a light rail route from Darwin to Palmerston, being included within a master plan in 2014 for Darwin (Keys 2016). Both Darwin and Hobart have made provisions within their future strategic planning, however both are not investigating further given that it is not currently viable (Keys 2016).

2.6 Gold Coast Light Rail

On the Gold Coast, the light rail network currently consists of thirteen kilometres of track extending from Gold Coast University Hospital, to Broadbeach (Currie & Burke 2013; GoldLinQ 2013; Keys 2016; Ludlam 2010; Wilkie & Peterson 2010). Stage one of the Gold Coast light rail began operation on the 20th of July 2014, and was the first light rail project for an Australian regional centre (Keys 2016; Ludlam 2010). TransLink estimates that in its first year of operation, the patronage rates were 6.5 million passengers (Keys 2016).

In 1997 it was first proposed for a new transit corridor extending from north to south through the Gold Coast, in the 1997 Integrated Regional Transport Plan (Keys 2016). This is the point when planning and debate on the light rail network first began (Keys 2016). The *2005 South East Queensland Infrastructure Plan and Program*, the scheme for managing sustainable growth in South East Queensland, confirmed the light rail project as a priority (GoldLinQ 2013). In 2008, the light rail network scheme was committed to by both the Queensland State Government and the Gold Coast City Council local government (Keys 2016). With Infrastructure Australia, in 2009, officially endorsing the project, and thus was ready to proceed (Keys 2016). In that same year the Commonwealth Government committed to assisting in funding the project (Keys 2016).

Stage one of the project was delivered through Public Private Partnership between the Federal Government, Queensland State Government, Gold Coast City Council, GoldLinQ and the private sector (GoldLinQ 2013; Keys 2016; Wilkie & Peterson 2010). The GoldLinQ consortium, in 2011, was officially awarded the contract to construct the project worth $1.2 billion, to begin operation in 2014 (GoldLinQ 2013; Keys 2016; Wilkie & Peterson 2010). It was estimated that throughout the construction phase of this project six thousand jobs were created (Wilkie & Peterson 2010). The GoldLinQ consortium consisted of several partners, including:

- McConnell Dowell Constructors Pty Ltd,

- Bombardier Transportation Australia Pty Ltd, and
- KDR Gold Coast Pty Ltd (joint venture between Keolis and Downer EDI Ltd) (GoldLinQ 2013).

The need for this project was identified through the plan to improve public transport as envisaged by the Queensland Government (GoldLinQ 2013). As well as being a means to tackle the traffic congestion problems of this growing city (GoldLinQ 2013; Keys 2016). It is expected that by the year 2026, the Gold Coast will have a population of 800,000 residents (Keys 2016). The key outcome, and main focus of the regional transport plans, were to relieve and manage traffic congestion problems (GoldLinQ 2013; Keys 2016). The light rail network was also aiming to manage accessibility in the long term (GoldLinQ 2013).

In 2008, it was identified that the Gold Coast region was heavily car dependent, with public transport as a mode of transport accounting for less than five per cent of all travel (Keys 2016). Hence, the light rail project was implemented to facilitate a reduction in the car reliance, thus reducing the traffic congestion (Wilkie & Peterson 2010). It was also done to promote the urban redevelopment and investment of the Gold Coast region (Wilkie & Peterson 2010). Furthermore, this system was seen as a potential economic boost through promoting tourism (GoldLinQ 2013). Most importantly the Gold Coast light rail is envisioned to become an integral part of the public transport network (GoldLinQ 2013). The network is expected to become a more viable solution to residents and tourists through its links with feeder buses operating throughout the Gold Coast Region (GoldLinQ 2013).

This light rail system has been identified as an important tourism and transport factor for the Commonwealth Games in 2018 (GoldLinQ 2013). The system is expected to be the main mode of transport at the Commonwealth Games, providing access to the various venues and accommodation throughout the Gold Coast (GoldLinQ 2013).

Stage one of the Gold Coast light rail consists of sixteen stations, with a fleet currently of fourteen Bombardier Flexity 2 trams (GoldLinQ 2013). In Figure 2.9, it provides a detailed route map of the Gold Coast light rail stage one (GoldLinQ 2010). This fleet has a maximum speed of seventy kilometres per hour, are the length of three regular buses at 43.5 metres, 2.65 metres in width, and 3.4 metres in height (GoldLinQ 2013). These light rail vehicles have a cab at each end meaning that they are bi-directional (GoldLinQ 2013). Each light rail vehicle has the ability to carry 309 commuters at full capacity, with provisions on vehicles for those with wheelchairs and surfboards (GoldLinQ 2013). From Gold Coast University Hospital Station to Broadbeach South Station, the journey is 37 minutes in duration (GoldLinQ 2013).

An important aspect of constructing the light rail network was ensuring that it was future proofed (GoldLinQ 2013). These future proofing works consisted of:

- Upgrades to the stormwater and drainage infrastructure with more than eight kilometres installed ranging thirty centimetres to 1.8 metres in diameter pipes,
- Telstra Conduits at 64 kilometres,
- Energex Conduits installed for fifty kilometres,
- Upgraded over seven kilometres of water and sewage pipe, and
- Hundreds of upgrades to manholes and pits (GoldLinQ 2013).

Figure 2.9. Gold Coast light rail stage one route map (GoldLinQ 2010).

In addition to stage one of the Gold Coast light rail is further stages, with stage two currently under construction, and a further stage three proposed (Keys 2016). Construction on the $420 million stage two began in 2016, and is expected to be completed in early 2018, in time for the 2018 Commonwealth Games (Keys 2016). Stage two involves an extension of 7.2 kilometres from the current terminal station of Gold Coast University Hospital to Helensvale (Keys 2016). This will involve the addition of three new stations, namely Helensvale, Parkwood, and Parkwood East (Keys 2016). The second stage will also involve the addition of 1400 car parking spaces at the stations (Keys 2016). Most critically the second stage will provide a link between heavy rail at Helensvale and the light rail at the Gold Coast University Hospital (Keys 2016). Currently this link is provided through feeder buses (Keys 2016). The link is critical as it provides the connection with the entire South East Queensland train network (Keys 2016). Stage three of the project is a long term plan to extend the network from Broadbeach South Station, through to Coolangatta and Gold Coast Airport (Keys 2016).

2.7 Conclusion

This literature review has identified the importance of having a highly accessible public transport network to a wide variety of users. Public transport accessibility is the ability for an individual to reach their desired destination from their origin through a particular mode of travel (El-Geneidy et al. 2016; Hawas et al. 2016; Mavoa et al. 2012; Yigitcanlar et al. 2007). Factors to consider when assessing accessibility were identified, generally categorised into: (1) access to transport stops, (2) duration of public transport journey, and (3) access to destinations via public transport (Mavoa et al. 2012).

Light rail, in recent years has experienced a resurgence around the world, as a solution to the increasing traffic congestion on roads (Currie & De Gruyter 2016; Keys 2016; Wilkie & Peterson 2010). In particular, light rail is a preferred mode of public transport to implement in dense urban areas and CBDs, to substitute buses, and a means for urban renewal (Wilkie & Peterson 2010).

Light rail in Australia is currently used, or has been considered in the majority of capital cities (Keys 2016). Stage one of the Gold Coast light rail system is operational, stage two is under construction, and future stages proposed (Keys 2016). In order to achieve good patronage, and equity to all potential users, the light rail system must include accessibility in its plans and policies.

The factors important to determining the accessibility of a light rail have been identified in this literature review. In the next chapter, these factors will be assessed for the light rail network on the Gold Coast.

CHAPTER 3

3.0 METHODOLOGY

3.1 Introduction

The purpose of this chapter is to identify the method and methodology for undertaking this research.

In the first section, the research paradigm is identified as well as the justification for choosing this paradigm as opposed to other paradigms. It identifies a method and methodology, and provides an overview of the method and methodology for this research.

The second section of this chapter provides an explanation on the choice of this case study. Specifically, the reasoning for undertaking this research as a case study, and its relevance to the aim of this research. It will also include an in depth explanation on the sampling strategy, including the justification for using this sampling strategy, the stations selected, and justification for selecting these stations.

The method of data collection will be identified in the third section of this chapter. This will include the type of data (primary or secondary) to be collected, and the two phases of this research. The method of colleting the data for the two phases including when this data will be collected. The framework developed as part of this research including the specific elements to be assessed, and the weighting system to be used for the data collection. The formulas to be used as part of the social accessibility phase. It will identify the resources required to successfully undertake the data collection. The type of data that will be collected (qualitative or quantitative). Finally, the relation of this data collection method to the research questions of this thesis.

The next section involves explaining how the data that is collected is going to be analysed. This includes how the different types of data will be presented, as well as the statistical analysis involved with this analysis.

In section five, the quality of the study will be explained. The study quality includes the validity, reliability, and generalisability of the research methods used.

In section six, it will identify the limitations and delimitations of undertaking this study. These relate specifically to the limitations of this research being undertaken for the purposes of an undergraduate honours research thesis. The delimitations identify the justification for considering the scope of this research.

In the final section, it will identify the ethical considerations as part of undertaking the data collection. Specifically, this relates to the data being collected in a public place.

3.2 The Research Paradigm and Methodology

For this research, the research paradigm will be a mixed methods research approach, as both qualitative and quantitative data will be collected. A research paradigm is the belief system or theory that sets out the practices, other research paradigms include quantitative and qualitative paradigms (Denscombe 2008). A mixed methods research involves the combination of both quantitative and qualitative methodologies into a single research (Bergman 2008).

The rationale for researchers using a mixed methods paradigm is for four main reasons, including enhancement, completeness, triangulation, and sampling. The most common rationale suggested by researchers is enhancement (Bryman 2008). For the purposes of this study, the justification for using a mixed methods paradigm is for completeness. Completeness refers to the notion of a researcher being able to provide a more comprehensive explanation of the research focus, if both qualitative and quantitative methods of research are used (Bryman 2008). Through using the quantitative methods, it allowed for a weighting of the

Gold Coast light rails' accessibility to be produced. It also allowed for the social accessibility element to be answered, through the use of the relevant equations.

The qualitative methodology for this thesis allowed for an observational accessibility of the Gold Coast light rail to be produced. Through this, issues or benefits of the accessibility of the Gold Coast light rail will be presented. Based on the above justification, it is considered appropriate to undertake this research with a mixed methods paradigm.

The method as part of the research is the technique or tool used to collect data, such as interviews. Whereas, methodology refers to the justification for a researcher using that particular method for their research (Kuada 2012). The method used as part of this research was the use of a framework, and equations to assess the accessibility of the Gold Coast light rail, this will be explained in more detail in section 3.4 Data Collection of this chapter. An extensive justification for assessing three stations as part of the methods is provided in section 3.3.2 Sampling Strategy – What and Why?

The justification for choosing a framework and mathematical equations as part of the methodology relates to the constraints of the thesis. A major constraint was time and cost of this research. Therefore, it was not possible to undertake a more extensive accessibility assessment similar to that conducted by other researchers (Curtis & Scheurer 2016; Dadhich & Hanaoka 2012; Geurs et al. 2016; Hawas et al. 2016; Mavoa et al. 2012; Saghapour et al. 2016a; Yigitcanlar et al. 2007). However, the accessibility framework was guided by these researchers and adapted to this research. The elements as part of the framework were chosen based upon the relevant *Disability Standards for Accessible Public Transport Act 2002 Act,* and the importance of other elements identified in the literature. This accessibility framework was aimed at determining the first and second research question to identify the physical and integrated transport accessibility of the Gold Coast light rail.

For social accessibility, the equations were selected based upon the requirements of the specific research question (El-Geneidy et al. 2016). These formulas result in travel cost and travel time expressed in both monetary terms and time (El-Geneidy et al. 2016). The third research question is to determine the travel cost and travel time accessibility of the Gold Coast light rail.

3.3 The Choice of Case Study

In this section it will provide an in depth explanation of the aim of this research, justifications as to why this has been undertaken as a research in part one. In part two of this section it will identify the sampling strategy used, as well as justification for using this particular sampling strategy.

3.3.1 Single Case – Justification and the Case Study

The aim of this research was to investigate the accessibility of the Gold Coast light rail system. Given the aim of this research, it was considered to be an exploratory study through a case study. Furthermore, as no previous research exists on the Gold Coast light rail accessibility it allowed for an investigative study. A case study is an in depth investigation into a particular situation (Habib et al. 2014). A case study allowed for the results to give an indication and elaboration for further research into the scope of the research (Habib et al. 2014).

3.3.2 Sampling Strategy – What and Why?

The sampling strategy chosen for this research is a non-probability sampling method. A non-probability sampling strategy involves a sample being selected on the basis of the researcher's personal judgement and discretion (Habib et al. 2014). Within non-probability sampling there are several types including: purposive sampling (or judgement sampling), convenience sampling, and quota sampling (Habib et al. 2014; Setia 2016).

The technique used for purposive sampling is through using 'logic, common sense, or sound judgement' to select a sample that is considered representative of the population (Habib et al. 2014, p. 32). For this research, it involved selecting three stations, based upon purposive sampling. There are several reasons relating to selecting three stations from the sixteen stations of the Gold Coast Light Rail. Through selecting three stations, as opposed to one or two, it is considered that this will allow for a sufficient overall assessment of the Gold Coast Light Rail. Other research into the accessibility of a public transport system often looks at multiple stations or stops within the network, as opposed to only one station. Guers, La Paix, and Van Weperen (2016), in their study selected 28 stations from the 54 stations.

The stations selected include Gold Coast University Hospital, Southport Station, and Cavill Avenue Station, refer to Figure 3.10 below. These stations were selected based on the common Land Use Destinations (LUDs), or Points of Interest (POI), commonly used in determining accessibility. These LUDs and POIs are of importance as they relate to the definition of accessibility, which is the ability for an individual to access end destinations from their origin through a particular mode of transport (Mavoa et al. 2012). The common LUDs, and POIs are Education, Employment, Financial, Health, Retail, and Social and Recreation (Mavoa et al. 2012; Saghapour et al. 2016b, 2016a; Yigitcanlar et al. 2007). For this research, the LUDs and POIs that determined the station selected were employment, education, health, and social and recreation. The Southport Station was selected as it is the Central Business District (CBD) for the Gold Coast, as such considered the employment centre for the Gold Coast (Gold Coast City Council 2017). Cavill Avenue Station in Surfers Paradise was selected as it is considered the central hub for tourists, as part of the social and recreation LUD (Gold Coast City Council 2014). The Gold Coast University Hospital Station is located within the Gold Coast Health and Knowledge Precinct, refer to Figure 3.11 below, which includes both health and education LUDs (Department of Local Government Infrastructure and Planning 2016).

Figure 3.10. Stations of the Gold Coast Light Rail selected (GoldLinQ 2010).

Figure 3.11. Gold Coast Health and Knowledge Precinct Master plan 2016 (Department of Local Government Infrastructure and Planning 2016).

3.4 Data Collection

The data collection for this research involved both primary and secondary data. Primary data is data that requires the researcher to collect information required for their research, it is often in a raw format (Habib et al. 2014). Whereas secondary data is sourced from work that has already been undertaken previously, most notably from a census (Habib et al. 2014).

The data collected for this study can be divided into two main groups: physical accessibility – which will involve data collection through primary data – and social accessibility – which will involve data collection using secondary data sources. The data collection was conducted in two phases, based on the above groups of physical accessibility and social accessibility. This phasing is necessary as the physical accessibility required data to be collected on site, whereas, the social accessibility did not require physical access to the site. This data collection was necessary to answer the main research question, which is how accessible is the Gold Coast light rail system?

3.4.1 Physical Accessibility Data Collection

The physical accessibility phase required data to be collected through the use of a framework that has been developed specifically for this research an unfilled copy is provided below in Table 3.3 to Table 3.7. This data was collected on a weekday, at peak times between 3:30pm and 7:00pm. These times were selected as it was anticipated to be its busiest, hence, allow for the assessment of accessibility at its busiest time. By being the busiest time of day, this could affect the level of accessibility, through having more people, this allowed for a determination as to whether the accessibility is affected.

Table 3.3. Accessibility Framework Form 1.

Form 1: Background Information	
Name:	
Date & Time:	
Station Location:	
Weather Conditions:	
General Comments:	
Summary:	
Form 2 (General Facilities):	
Form 3 (Bicycle Facilities):	
Form 4 (Elderly & Disabled):	
Form 5 (Integrated Transport Accessibility):	
Total:	

Table 3.4. Accessibility Framework Form 2.

Form 2: General Facilities				
Toilets	Are there toilets at station?	Yes	No	Don't Know
	Condition of the toilets?	Good	Average	Poor
	Comments:			
	Rating	0	1	2
Ramps/Lifts	Are there ramps/lifts?	Ramps	Lifts	Nil
	Ramp Minimum Width?			
	Comments:			
	Rating	0	1	2
Ease to embark/disembark light rail vehicles	No. entry/exit points			
	Height Difference?			
	Time to board?			
	Comments:			
	Rating	0	1	2
Information	Next tram?	Yes	No	Don't Know
	Timetable	Yes	No	Don't Know
	Next Station?	Yes	No	Don't Know
	Map of surrounding area?	Yes	No	Don't Know
	Multiple Languages?	Yes	No	Don't Know
	Comments:			
	Rating	0	1	2
Ease to use ticket machines	Go card points?			
	Ease to purchase tickets?			
	Payment Options?			
	Comments:			
	Rating	0	1	2
Ease/safety to enter/exit station	Type of Crossing:			
	Time to cross at signalised?			
	Break in traffic at unsignalised?			
	Are there kerb ramps?			
	Lanes to Cross?			
	Location/Number of Crossings:			
	Comments:			
	Rating	0	1	2
Seating at station/light rail vehicles	Seating Provided?	Yes	No	Don't Know
	Capacity			
	Comments:			
	Rating	0	1	2

Table 3.5. Accessibility Framework Form 3.

Form 3: Bicycle Facilities				
Racks	Are racks provided at stations?	Yes	No	Don't Know
	Location/Number?			
	Comments:			
	Rating	0	1	2
Usability of trams	Bike on board facilities?	Yes	No	Don't Know
	Drinking Water facilities?	Yes	No	Don't Know
	Comments:			
	Rating	0	1	2
End-of-trip facilities	Facilities provided:	Yes	No	Don't Know
	Location/Number?			
	Comments:			
	Rating	0	1	2

Table 3.6. Accessibility Framework Form 4.

Form 4: Elderly & Disabled				
Boarding	Gap between vehicle and station?			
	Boarding Device?	Yes	No	Don't Know
	Comments:			
	Rating:	0	1	2
Allocated space	Size?			
	Number?			
	Symbol?	Yes	No	Don't Know
	Comments:			
	Rating:	0	1	2
Braille on signs	Do signs have braille?	Yes	No	Don't Know
	Number?			
	Comments:			
	Rating:	0	1	2
Tactile ground surface indicators	Indicators installed (access path: stair, ramp, direction change)?	Yes	No	Don't Know
	Locations?			
	Comments:			
	Rating:	0	1	2

Table 3.7. Accessibility Framework Form 5.

Form 5: Integrated Transport Accessibility			
Does light rail integrate with following transport modes?			
Taxis	Yes	No	Don't Know
Buses	Yes	No	Don't Know
Heavy Rail	Yes	No	Don't Know
Cars	Yes	No	Don't Know
Walking	Yes	No	Don't Know
Bicycling	Yes	No	Don't Know
Comments:			
Rating:	0	1	2

The framework developed as part of this research included the elements identified in the literature review, and the *Disability Standards for Accessible Public Transport 2002* Act, that are considered important to accessibility of a public transport system. These included elements that relate to the direct accessibility including the general facilities, bicycle facilities, aged and elderly, and disabled and mobility impaired, and integration with other transport modes.

The direct accessibility can be defined as the physical design of the Gold Coast light rail stations. Within the direct accessibility, several elements were assessed, including general facilities, bicycle facilities, aged and elderly, and disabled and mobility impaired. In the following paragraphs, the indicators to assess each element will be identified.

For the general facilities, it involved an assessment of the features that are considered critical to the physical design of a public transport station. These include the following indicators: toilets; ramps/lifts; ease to embark and disembark light rail vehicles; information (next light rail vehicle, maps, next station, multi-lingual functions); ease to use ticket machines; ease to enter and exit station; safety of station (accessing station, ingress/egress from light rail vehicles); and seating provided.

For the bicycle facilities, the provision of the appropriate facilities considered valuable to riders can result in increased public transport ridership (Flamm et al. 2014; Geurs et al. 2016).

As such, the indicators have been developed based upon the facilities considered valuable to riders. These indicators include racks, usability of light rail vehicles (ingress/egress, on-board facilities), and the "end-of-trip" facilities.

The factors relating to the aged and elderly, and the mobility impaired and disabled, are related. Therefore, for this study, these two elements were combined. Having good accessibility for those elderly or disabled is critical given that these user groups are considered the most vulnerable, and are most reliant upon an accessible public transport system. Furthermore, in Australia, the *Disability Standards for Accessible Public Transport 2002* act, legislates that all public transport services must be accessible to the levels prescribed within the *Act (Disability Standards for Accessible Public Transport 2002)*. The indicators considered for the elderly and disabled are obtained from this *Act*. The indicators include: boarding, allocated spaces, access path (ramps, lifts), use of braille on signs, and tactile ground surface indicators.

For the disabled and elderly elements, the framework elements were assessed based on compliance with the legislation (Disability Standards for Accessible Public Transport 2002). For boarding, a boarding device must be available, and a signal to request the use of boarding device. For allocated space, a minimum of 800 mm by 1300 mm for a single wheelchair, and at least two allocated spaces for each light rail vehicle. For access paths it must be unhindered, continuous passage, a minimum 1200 mm, and a minimum 800 mm through doorways. For Braille, it must be provided on all signs, and at least 0.8 mm above the sign surface. For tactile ground surfaces it must be installed on all access paths to indicate stairways, ramps, change of direction, overhead obstruction below 2000 mm, and any other hazards, and installed at the edges of light rail platforms.

Included within the physical accessibility, was the integrated transport accessibility, which is the linkage of the Gold Coast light rail to other modes of transport including: taxis, buses, heavy rail, cars (including car parking, and pick up/drop off facilities), walking, and bicycling.

A highly accessible transport system is identified as one that has the ability to integrate a variety of modes of transport (Saghapour et al. 2016a).

Integrating light rail with other forms of public transport including buses, and heavy rail, allows for the system to be sustainable (Curtis & Scheurer 2017). This also allows for increased ridership, as the reach of the network is greater (Curtis & Scheurer 2017).

Integrating public transport with walking has been shown to be mutually beneficial as it promotes a routine of physical activity, improves health and increases public transport patronage (Djurhuus et al. 2014). A public transport system is generally positively associated with an increase in walking (Barr et al. 2016). Thus, suggesting it is important for walking to be integrated with public transport.

Similar to walking, integration with bicycling has shown to be beneficial as it increases public transport ridership, and improves health (Flamm et al. 2014; Geurs et al. 2016). Most importantly bicycling has the ability to extend the catchment area of a public transport station (Geurs et al. 2016). This is important to improving integration accessibility, to facilitate the use of public transport to a larger group of users (Geurs et al. 2016).

In assessing the physical accessibility in the framework, the different factors will be assessed using a weighting system. This weighting system will be similar to that used in the PTWAI and the IPTN (Fransen et al. 2015; Mavoa et al. 2012). This weighting system identified an accessibility score based on a scale. A weighting system was chosen for the framework as it allowed for several indicators to be assessed based upon research identified in the literature review (Fransen et al. 2015; Mavoa et al. 2012). This scale ranges from zero to two of no accessibility, to average accessibility, to high accessibility, as seen in Table 3.8. The framework also provided the ability to make comments generally about the station, as well as specifically for different elements. The framework will also collect data through the use of photographs.

Table 3.8. Weighting Scale.

Accessibility Score	Level of Accessibility
0	**No Accessibility** (lack of provision of element, needs to be implemented)
1	**Average Accessibility** (element provided marginally passes as accessible requires some improvements)
2	**High Accessibility** (element provided, would promote use, no improvements necessary)

3.4.2 Social Accessibility Data Collection

The second phase involved assessing the social accessibility of the Gold Coast light rail. The social accessibility can be described as the ease of accessibility to different user groups in terms of cost and time, including students, elderly, disabled, and low socio-economic individuals. For this indicator, it used the measure identified by Saghapour, Moridpour, and Thompson (2016). This type of measure is the travel time and costs which measures the ability for an individual to access their destination through accounting for the travel time or cost of using the public transport network (Saghapour et al. 2016a).

The social accessibility of the Gold Coast light rail was determined overall for the entire network as opposed to a selected group of stations. The social accessibility was determined through using Equation 2.2 and 2.3, developed by El-Geneidy et al. (2016). The equation calculated the travel time and travel cost expressed in both monetary terms and travel time. These formulas require data including the minimum wage per hour, and the cost of a single transit fare. This data was sourced from two freely available sources. The equation required the minimum wage per hour which was $18.29, this value was derived from the minimum wage for Australia from the Fair Work Ombudsman (Fair Work Ombudsman 2017). The travel time used was one hour to determine cost of travel per hour. The transit fare was based upon four different types of fares, including:

1. Go Card Adult: $3.20
2. Go Card Concession: $1.60
3. Paper Adult: $4.60

4. Paper Concession: \$2.30 (TransLink 2017).

Equation 2.1 presents the travel time and travel cost in monetary terms

$$C_{ij} = t_{ij}w + F_{ij} \tag{2.1}$$

Where

C_{ij} is the time cost of travel

t_{ij} is the travel time in hours

w is the minimum wage per hour

F_{ij} is the transit fare

Equation 2.2 presents the travel time and travel cost in time

$$C_{ij} = t_{ij} + \frac{F_{ij}}{w} \tag{2.2}$$

Where

C_{ij} is the time cost of travel

t_{ij} is the travel time in hours

w is the minimum wage per hour

F_{ij} is the transit fare

Social accessibility of a network is considered important as it ensures that users have equitable access (El-Geneidy et al. 2016). This is important particularly for those considered vulnerable including those that are in the low socio-economic demographic (Saghapour et al. 2016a). Therefore, to ensure a public transport system is accessible it is important to consider the travel time and travel cost. Having good social accessibility means those vulnerable individuals are able to reach their desired destinations within reasonable times and costs (Hawas et al. 2016).

3.4.3 Resources Required

For this thesis, there were minimal resources required. For the literature resources, it was acquired through the University of Southern Queensland Library, as well as supplementary literature through Google. To facilitate this, access was through the use of computers at the University of Southern Queensland and through the use of personal computer. Both of these computers had access to the Microsoft Office Suite, as well as EndNote.

To undertake the data collection, it required physical access to the Gold Coast light rail. Travel to the Gold Coast was estimated to cost $60.00 through a personal vehicle. This cost was covered for by the writer. To physically access the Gold Coast light rail system, and use it as a mode of travel was estimated to cost $10 per day. This cost was covered by the writer.

To aid in carrying out the assessment of the Gold Coast light rail recording of the data on the framework was critical. This was through using Microsoft Word app on an iPad. This iPad was the personal device of the writer. As a backup, paper recording was carried out. It was also necessary to take photographs, this was through a DSLR camera that was a personal device of the writer. A tape measure was also necessary to aid in carrying out measurements for elements of the framework. This was supplied by the writer.

Other data that was required to be collected was through the use of Google Earth, TransLink, Fair Work Ombudsman and Australian Bureau of Statistics, which was freely available.

3.4.4 Types of Data

As this is a mixed method study, the data included both qualitative and quantitate data. Qualitative data is information that is not in numerical form, whereas, quantitative data is in numerical form. The qualitative data for this study included the photographs taken and comments as part of the framework. For the quantitative data, it included the results of the weighting scale of the framework, and the results from the formulas used in the social accessibility phase. The compliance assessment of the disabled and elderly element will also result in quantitative data.

3.4.5 Research Questions

The purpose of undertaking the data collection method was to answer the research questions for this study. The first research question is to determine the direct accessibility of the Gold Coast system to its users. This question relates to the direct accessibility section of the physical accessibility. Therefore, the direct accessibility framework will aim at answering the research question through assessing the various indicators considered important.

The second research question is to determine the accessibility of the Gold Coast light rail in terms of its integration with other modes of transport. Hence this question relates to the second section of the physical accessibility which is integrated transport accessibility. Thus, the integrated transport accessibility framework will aim at identifying the Gold Coast light rails' integration with other forms of transport.

The final research question is to determine the travel cost and travel time accessibility of the Gold Coast light rail system. This question relates to the second phase of this study through collecting data relating to travel time and travel cost. The formula will be used to identify the accessibility of the Gold Coast light rail in terms of affordability, and travel time to its users.

3.5 Data Analysis

The results of the data are presented through the use of tables and graphs, to diagrammatically display the results. This will include summarising diagrammatically the results of the assessment of the three stations for the physical accessibility. The data presented will also include the photographs that were taken as part of the data collection.

The data analyses involved a statistical analysis of the quantitative data. These statistical analyses will include using mean and median, distribution, range, and standard deviation. The qualitative data analysis will involve the identification of common and different elements of accessibility. The data analysis will also involve comparison with the accessibility of other light rail networks in Australia, as well as providing recommendations as to how the accessibility could be improved, if it requires improvement.

The data analysis of three stations was done individually, as opposed to an overall assessment of the three stations combined. This was to ensure that the accessibility results for each station were presented and analysed to reflect the level of accessibility for that particular station. This was to prevent a varying result for one station was not affected by the results of the other two stations.

3.6 Quality of the Study

The quality of the study involved an assessment of the validity, reliability, and generalisability of this research. Validity relates to the accuracy of the measure, or the extent to which the results represent what it is truthfully (Habib et al. 2014). To ensure the validity of this research, the data collection tool developed, was based upon the elements considered important to accessibility. For example, the disability and elderly elements are developed based upon the *Disability Standards for Accessible Public Transport 2002.* The framework is considered valid as it addresses the relevant elements identified by other researchers, and legislative frameworks. The social accessibility methodology is considered valid as it is based upon the formula used in previous research.

The reliability of a study relates to the consistency of the measurement. That is the measurement of accessibility will produce the same result with different attempts (Habib et al. 2014). To ensure reliability for social accessibility, the formula used was the same that is used by El-Geneidy et al. (2016). This formula was replicated, the only differences were the fare cost and minimum wage relevant to the Gold Coast. To maintain reliability of the physical accessibility, the measurement system clearly defined this is to allow for repeatability of the research.

Generalisability relates to the ability to extend the results of the research beyond what was examined in the study (Habib et al. 2014). As the physical accessibility portion involved the assessment of only three of the sixteen stations, it would not be possible to provide a definitive answer to the physical accessibility of the Gold Coast light rail. However, through the data collection, trends of accessibility may appear, which could lead to generalising the Gold Coast light rail. This could lead to an indicative result of the Gold Coast light rails' physical accessibility. The social accessibility could be generalised to the entire Gold Coast light rail system, as the accessibility will be constant.

3.7 Limitations and Delimitations

The main limitations of this study are the time and cost constraints, this is due to this research being for an undergraduate honours research thesis. This relates to the methodology used, given the time and cost constraints, it is not possible to undertake research that potentially uses a different framework. Given the time constraints, this limits the results to the current operations of the Gold Coast light rail. In the future when further stations become available, this could change the accessibility results.

Another limitation is that the data collection will involve an actively used site. This could potentially prevent the required data to be collected. This could relate to being unable to take the measurements required for the disabled and elderly element of the direct accessibility.

The delimitations of this study are predominantly related to the consideration of only physical and social accessibility. For this study, the researcher was specifically interested in the physical accessibility of stations, and the affordability and travel times. For this study, the accessibility of the Gold Coast light rail was only considered as opposed to the entire Gold Coast public transport system. The reasoning for only focusing on the Gold Coast light rail was the time constraints of this thesis.

The study has only selected three stations as part of this study. This was also mainly due to the time constraints of the research. Another delimitation is that the accessibility does not investigate the accessibility of the areas surrounding the stations. It also does not consider the perceived accessibility, which involves the surveying of users of the public transport network. These limitations are again due to time and cost constraints mainly. However, also for the nature of this undergraduate research thesis, it would have resulted in the scope of this thesis being too large.

3.8 Ethical Considerations

The main ethical consideration for this research are related to the fact that the researcher will be collecting data in a public place. As it is within a public place, it may cause issue with the public's right to privacy and dignity. To ensure the data collection is undertaken ethically it mainly involved ensuring that any photographs taken do not include members of the public. To protect the dignity of the public, ethically it involved remaining objective throughout data collection and analyses. This ensured no subjective judgement on an individual is made.

3.9 Conclusion

In this chapter, it identified the method and methodology used to undertake this research. It identified the mixed methods paradigm, and justification for using this paradigm. As well as an explanation of the methods and methodology.

The identification of this mixed methods study as a case study, and a justification for using a case study as part of the research. It included identifying and justifying using purposive sampling as the sampling strategy, and the stations selected to be assessed.

The use of both primary and secondary data collection, and the two phases (physical and social accessibility) were identified. The use of a framework and formulas as part of the two phases, as well as a detailed explanation of this framework. It identified the resources required, and the collection of both qualitative and quantitative data. Finally, how this data collection method relates to the research questions. Table 3.9 below provides a summary of the data collection.

The next section identified how the data was going to be analysed and presented, for the different types of data.

The quality of the study, including the validity, reliability, and generalisability of the research was explained.

The limitations and delimitations of undertaking this research were explained and how this relates to the research scope.

Finally, the ethical considerations as part of undertaking the data collection, specifically, the data collection occurring in an actively used a public space.

Table 3.9. Summary of data collection.

Measure	**Type** (Qualitative & quantitative)	**Category**	**Collection Method**
General Facilities:	Qualitative & quantitative	Physical: direct accessibility	Framework
Toilets	Quantitative	Physical: direct accessibility	Framework
Ramps/Lifts	Quantitative	Physical: direct accessibility	Framework
Ease to embark/disembark light rail vehicles	Quantitative	Physical: direct accessibility	Framework
Information (next station, light rail vehicle)	Quantitative	Physical: direct accessibility	Framework
Ease to use ticket machines	Quantitative	Physical: direct accessibility	Framework
Ease/safety to enter/exit station	Quantitative	Physical: direct accessibility	Framework
Seating at station and on light rail vehicles	Quantitative	Physical: direct accessibility	Framework
Bicycle Facilities:	Qualitative & quantitative	Physical: direct accessibility	Framework
Racks	Quantitative	Physical: direct accessibility	Framework
Usability of light rail vehicles	Quantitative	Physical: direct accessibility	Framework
“end-of-trip” facilities	Quantitative	Physical: direct accessibility	Framework
Elderly/Disabled:	Qualitative & quantitative	Physical: direct accessibility	Framework

Boarding	Quantitative	Physical: direct accessibility	Framework
Allocated Space	Quantitative	Physical: direct accessibility	Framework
Braille on Signs	Quantitative	Physical: direct accessibility	Framework
Tactile Ground Surface Indicators	Quantitative	Physical: direct accessibility	Framework
Integrated Transport Accessibility	Qualitative & quantitative	Physical: integrated transport accessibility	Framework
Taxis	Qualitative	Physical: integrated transport accessibility	Framework
Buses	Qualitative	Physical: integrated transport accessibility	Framework
Heavy rail	Qualitative	Physical: integrated transport accessibility	Framework
Cars	Qualitative	Physical: integrated transport accessibility	Framework
Walking	Qualitative	Physical: integrated transport accessibility	Framework
Bicycling	Qualitative	Physical: integrated transport accessibility	Framework
Social Accessibility: travel time and travel cost	Quantitative	Social Accessibility	Formula 2.1. & 2.2

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CHAPTER 4

4.0 RESULTS

4.1 Introduction

The purpose of this chapter is to present the results from undertaking the data collection of the Gold Coast light rail. The accessibility frameworks were used to determine the level of accessibility of the Gold Coast light rail. The frameworks can be categorised into four groups: general facilities, bicycle facilities, elderly and disabled accessibility, and the integrated transport accessibility. In this chapter, the results from each of three stations will be presented in the aforementioned groups. This chapter will also include an analysis of the results.

The different elements for each group includes a weighting between zero (no accessibility), one (average accessibility) to two (high accessibility). Included within the results are photographs to provide a visual of the level of accessibility. An entire completed accessibility framework can be found in Appendix B. In Appendix C detailed and further photographs to those supplied in this chapter can be found.

4.2 Gold Coast University Hospital Station

The Gold Coast University Hospital is currently a terminal station at the north of the Gold Coast for the light rail. This station is only partially operational, with one platform currently under construction. These construction works are a part of stage two of the light rail which extends the network from this station to Helensvale. This station is also the only station that is completely underground. In Figure 4.12 the map identifies the different elements of facilities available at the station, a more detailed map is available in Appendix D.

Figure 4.12. Gold Coast University Hospital Station map.

The Gold Coast University Hospital station accessibility was a total of 21 out of 30 (refer to Table 4.10). The general facilities were a total of 12 out of 14. For the bicycle facilities, this station scored 3 out of 6. For the elderly and disabled accessibility, the results were 5 out of 8. For the Integrated Transport Accessibility, the score was 1 out of a possible 2.

Table 4.10. Summary of the results for the Gold Coast University Hospital Station

Summary: Gold Coast University Hospital Station	
General Facilities	12
Bicycle Facilities	3
Elderly and Disabled Accessibility	5
Integrated Transport Accessibility	1
Total Accessibility	21

4.2.1 General Facilities

For the general facilities at the Gold Coast University Hospital Station, several elements were assessed that influenced accessibility for this station. The first element was toilets at the station which scored a rating of 1. This was due to the station having toilets with an average condition. The station had two disabled, unisex toilets, with one toilet having baby changing facilities (refer to Figure 4.13 below).

Figure 4.13. Toilets at Gold Coast University Hospital Station

The Gold Coast University Hospital Station had two lifts as it was underground (see Figure 4.14). There were no ramps at this station underground as it was all level. The station did have stairs also to get to street level. These steps exited the street at three different locations. As such this station scored a two on the accessibility framework.

Figure 4.14. Lift at Gold Coast University Hospital Station.

The ease to embark and disembark the light rail vehicles at this station was rated a two. As this station is a terminal station currently it has a longer boarding time of three minutes. The number of entry and exit points was a total of eight with six being double doors and two being a single door. The height difference between the light rail vehicle and the station platform was approximately fifty millimetres (refer to Figure 4.15). However, it should be noted that this level can change by a few centimetres depending on the amount of people on board the tram.

Figure 4.15. Height difference between the platform and light rail vehicle.

The information available at the station was good, hence rated an accessibility score of two. Each platform had a digital display of the next two trams on that line and their estimated time of arrival (see Figure 4.16). The station had no real timetable as such that indicated the exact time the trams would arrive apart from the next two trams. The timetable indicated the regularity of the trams such as every 7.5 minutes on weekdays between 7am and 7pm (refer to Figure 4.17). The station had a route map of the entire system at the station, a location map of the surrounding area including the next station as seen in Figure 4.18, specific photographs on the information can be seen in Appendix C. The station information was not in multiple languages.

Figure 4.16. Digital display of next two trams.

Figure 4.17. Tram timetable.

Figure 4.18. Station information available at Gold Coast University Hospital Station.

The next element was to determine the ease to use the ticket machines, this element scored a rating of one. The station had six go card points per platform at different points along the platform. The ticket machines would sometimes not accept payment or would cancel and so no ticket given. It should be noted that other individuals also had difficulty either asking the author for help or other individuals. The ticket machine accepts EFTPOS, PayWave, and cash, and allow for go cards to be topped up with money (see Figure 4.19).

Figure 4.19. Ticket machine at station.

The ease and safety to enter and exit the station was the next element which scored a two. By using the underpass of the station an individual could either enter or exit the station on the Gold Coast University Hospital side or the Griffith University side. The other crossings were all signalised, with an approximate crossing time between twenty and thirty seconds depending upon the crossing. All the kerbs had ramps that were level with the road and footpath.

The station had approximately sixteen seating spaces provided (refer to Figure 4.20). However, a bench at the back allowed for increased seating with many waiting passengers using the bench as a seat (see Figure 4.21). As such this station scored a rating of two.

Figure 4.20. Seating provided at station.

Figure 4.21. Bench at back used as seating.

4.2.2 Bicycle Facilities

The next factor assessed was the bicycle facilities at the Gold Coast University Hospital Station. The first elements were the bike racks provided at the station, which was rated a two (see Figure 4.22). At this station, the bike racks were provided at street level. There was only one bike shed with racks to hold up to approximately twenty bikes.

Figure 4.22. Bike shed at Gold Coast University Hospital Station

The next element is the usability of the trams with bikes which scored a 1. There is no bike on board facilities. Drinking water facilities are provided near the bike shed as well as one on the platform (refer to Figure 4.23). The final element considered was the end-of-trip facilities at the station. This station scored a zero as there were no facilities provided.

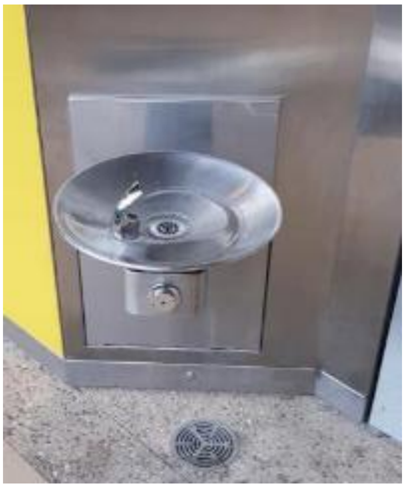


Figure 4.23. Water facilities at station.

4.2.3 Elderly and Disabled Accessibility

The elderly and disabled elements was the next to be assessed, which was assessed against the requirements of the *Disability Standards for Accessible Public Transport 2002 Act*. The first element was the boarding which scored a one. The gap between the vehicle and station was approximately fifty millimetres (refer to Figure 4.24). The *Act* indicates that gaps over forty millimetres must have a boarding device provided. A boarding device was available which will be deployed by the tram driver for wheelchair bound passengers.

Figure 4.24. Gap between platform and light rail vehicle.

For the allocated space on each platform, it was rated a score of two. There were four allocated spaces in total: two at the seating area (1300mm x 800mm), and two as designated boarding points (1400mm x 1520mm) (refer to Figure 4.25 and Figure 4.26). The designated boarding points had a blue symbol and stood out clearly. The seating area points were not as clear as the symbol was black and was difficult for the author to identify.

Figure 4.25. Boarding point allocated space.

Figure 4.26. Seating area allocated space.

The next element was the braille on the signs, at this station the signs did not have braille. As such the score for this element was a zero. The final element was the tactile ground surface indicators which scored a two. These indicators were provided at the yellow line, the stairways, and lift entries as seen in Figure 4.27 with more detailed photographs in Appendix C.

Figure 4.27. Tactile Surface Indicators.

4.2.4 Integrated Transport Accessibility

The final factor was the integrated transport accessibility, for the Gold Coast University Hospital Station the rating was one. At this station it integrated with buses, walking, and bicycling. At street level, the bus station was provided that was accessible without the need to cross the road (refer to Figure 4.28). The walking and bicycling was integrated through providing bike racks, footpaths to the surrounding destinations and signalised crossings to ensure safe passage. The station did not integrate with taxis, heavy rail, or cars. The nearby taxi rank as part of the Gold Coast University Hospital could be used.

Figure 4.28. Bus station.

4.3 Southport Station

The Southport Station is a street level station located in the Gold Coast CBD. The station is located in the middle of a pedestrian mall, with one way access to private properties on the north side of the station. In Figure 4.29 the map identifies the different elements of facilities available at the station, a more detailed map is available in Appendix D. The total accessibility score for Southport Station was 19 out of 30 (refer to Table 4.11). The general facilities score was an 11 out of 14, with the bicycle facilities a 2 out of 6. The elderly and disabled accessibility was a 5 out of 8. With the Integrated Transport Accessibility, a 1 out of 2.

Figure 4.29. Southport Station map.

Table 4.11 Summary of results for Southport Station

Summary: Southport Station	
General Facilities	11
Bicycle Facilities	2
Elderly and Disabled Accessibility	5
Integrated Transport Accessibility	1
Total Accessibility	19

4.3.1 General Facilities

The first accessibility factor considered was the general facilities at Southport Station. The first element was the toilets at the station, which scored a zero. This is because this station did not have any toilets. The local area map indicates public toilet facilities are located 400 metres or an approximate five minute walk from the station.

The next element is the ramps and lifts at the station. As this station is at street level there are no lifts, only ramps and stairs. At Southport Station, the accessibility score was a two. There are only four sets of stairs at this station with up to five steps on each. The tram station was designed to ensure the predominant walkway area was a ramp with a gradual gradient. These ramps lead out of the station to the footpath network or to traffic lights which have kerb ramps. With the exception being the ramp on the southside platform to the west which a significant change in height means a ramp is necessary (refer to Figure 4.30). This ramp was measured to be 2000 millimetres in width. Under the *Act* the minimum allowable width is 800 millimetres.

Figure 4.30. Ramp at Southport Station on southwest side.

The ease to embark and disembark the light rail vehicles was the predominantly the same as the Gold Coast University Hospital Station. The accessibility score was a total of two. There were eight entry and exit points with six double and two single doors. The height difference was also approximately fifty millimetres. The difference between the two stations was the length of time to board. On average at the Southport Station passengers have one minute to embark and disembark.

The information available at Southport Station was the same as the information available at the Gold Coast University Hospital Station, the difference was that this information was relevant to the Southport area (refer to Figure 4.31). The accessibility score for this element was a two. Each platform had a digital display overhead to indicate the next two trams on that platform, and their estimated time of arrival. The timetable was also not an actual timetable, it was only an indication on the regularity of a trams arrival. The station also included a route map of all the stations on the light rail network which can be used to determine the next station in either direction. The information available also included a map of the surrounding area. The map indicated what was available within an 800 metre walk or approximately ten minutes, this included significant points of interest in the area such as Australia Fair Shopping Centre. This information was not available in multiple languages, although their website has the ability to be in multiple languages (http://ridetheg.com.au/).

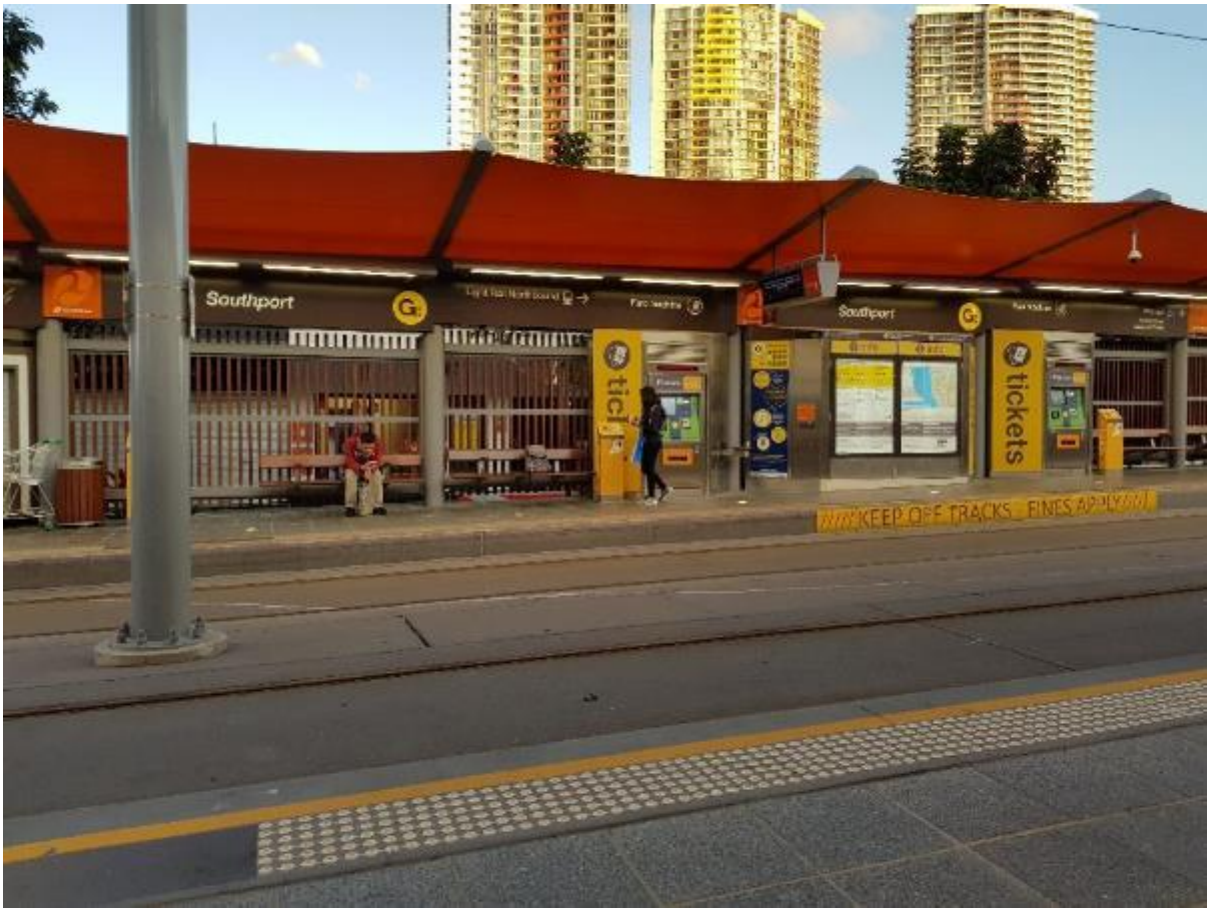


Figure 4.31. Platform 1 at Southport Station.

The ease to use the ticket machines scored a rating of one, and was the same as the Gold Coast University Hospital Station. There were six go card points on each platform at different points along the platform (see Figure 4.32). The ticket machines were sometimes difficult to use and did not always accept payments. Other individuals also seemed to have difficulty using the ticket machines. The machines accept EFTPOS, PayWave, and cash as payment options.

Figure 4.32. Go Card point at Southport Station.

At Southport Station, the ease and safety to enter and exit stations scored a rating of two. The area surrounding this station has signalised pedestrian crossings. These include tram track crossings, tram and traffic crossing and only traffic crossing. All the signalised crossings had kerb ramps. These crossings had a length of time to cross ranging from 20 seconds to the thirty seconds. The signalised crossings over the tram tracks were generally not used with individuals crossing whenever. Many individuals would cross between platforms wherever and whenever even in front of trams (refer to Figure 4.33). This could be a result of the long wait time before an individual can cross even if no tram is approaching.

Figure 4.33. Individual crossing between platforms.

At this station the seating scored a rating of two. There were approximately 24 seats available on each platform.

4.3.2 Bicycle Facilities

The next factor assessed was the bicycle facilities at this station. At this station there was bike racks which scored a total accessibility score of one. These racks were limited to two bike racks with a capacity of only four bikes. The racks were also difficult to locate (refer to Figure 4.34). The trams had no facilities on board to store bikes. The stations did have water facilities with one on each platform. A such the usability of the trams was a total of one. This station had no end-of-trip facilities.

Figure 4.34. Bike racks at Southport Station.

4.3.3 Disabled and Elderly Accessibility

The disabled and elderly accessibility was the next factor considered. The boarding at this station was similar to the Gold Coast University Hospital Station, and was rated a one. The gap between the light rail vehicle and the platform was approximately fifty millimetres. Under the *Act* this meant that a boarding device was required to be supplied. It is indicated that the tram driver will supply a boarding device if an individual is waiting in a boarding assistance allocated space.

The allocated space at this station was rated a two, and also the same as the Gold Coast University Hospital Station. There were four allocated spaces per platform, with two for boarding (1400mm x 1520 mm) and two for seating (1300 mm x 800 mm). These allocated spaces had the designated symbol as required by the *Act*.

As with the Gold Coast University Hospital Station, the signs at Southport Station also did not have braille on the signs. Therefore, this element was rated a zero.

This station did have tactile ground surface indicators, and was scored a two. These indicators were located at the yellow line, ramps, stairs, and road crossings.

4.3.4 Integrated Transport Accessibility

The final factor considered was the Integrated Transport Accessibility which had a total rating of one. The active modes of transport (walking and cycling) were well integrated with footpaths leading to significant destinations surrounding the station. There were also facilities provided such as drinking water and bike racks. This station also linked with the bus interchange an approximate 100 metre walk from the light rail station (see Figure 4.35). The station did not link up with heavy rail or taxis. The station also did not have park'n'ride facilities for cars.

Figure 4.35. Bus interchange at Southport Station.

4.4 Cavill Avenue Station

Cavill Avenue Station is located in Surfers Paradise, the central hub for tourists on the Gold Coast. The station at Cavill Avenue is a street level station which is along Surfers Paradise

Boulevard. At Cavill Avenue Station Surfers Paradise Boulevard is only open to one way traffic. The platform at the station seemed to the author to be small. It was noted that when it was approaching the next tram to be due the platforms would get busy. This was when the light rail vehicles were on the timetable of every 7.5 minutes. It was also noted that in the event of a large crowd wanting to use the light rail, the station may not be able to cater for the large number of patrons. In Figure 4.36 the map identifies the different elements of facilities available at the station, a more detailed map is available in Appendix D.

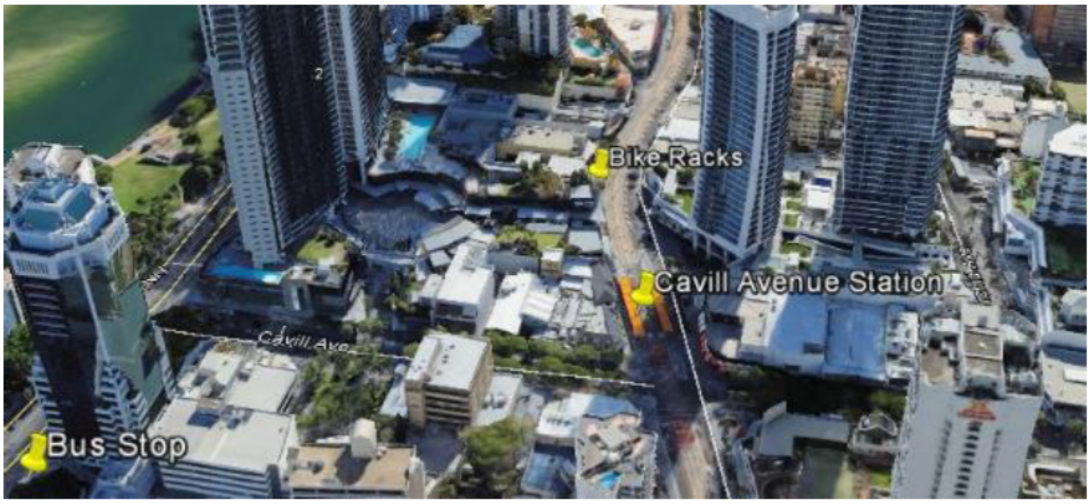


Figure 4.36. Cavill Avenue Station map.

The total accessibility score for Cavill Avenue was 19 out of a possible 30. A summary of these results can be found in Table 4.12 below. For the general facilities, this station was rated 11 out of a possible 14. The bicycle facilities scored an accessibility rating of 2 out of a possible 6. The elderly and disabled accessibility was a rating of 5 out of a possible 8. With the integrated transport accessibility rated a 1 out of a possible 2.

Table 4.12. Summary of results of Cavill Avenue Station

Summary: Cavill Avenue Station	
General Facilities	11
Bicycle Facilities	2
Elderly and Disabled Accessibility	5
Integrated Transport Accessibility	1
Total Accessibility	19

4.4.1 General Facilities

At Cavill Avenue Station there were no toilets, therefore this element was rated a zero. The local area map surrounding Cavill Avenue Station suggest that public toilets are available at several locations predominantly parks within a 400 metre or approximately five minute walk.

As this station is a street level station there were no lifts as there was no need for lifts. Cavill Avenue Station also did not have any stairs, only ramps. For this element the accessibility was a two. The station was designed to ensure that the platforms were level with the footpaths exiting the station. Although there was a small change in the ground height, these were not significant and the footpath had a gradual gradient, this is shown in Figure 4.37.

Figure 4.37. Footpath ramp at Cavill Avenue Station.

The ease to embark and disembark the light rail vehicles was similar to that of Gold Coast University Hospital Station and Southport Station. For Cavill Avenue Station this element was rated a two. The number of entry and exit points on the light rail vehicle was eight with six double doors and two single doors at both ends of the light rail vehicle. The height difference between the platform and the light rail vehicle was noted to be approximately 50 millimetres. However, it is important to indicate that this height may change depending on the number of people on board the light rail vehicle. The time to board a tram at Cavill Avenue was found to be approximately one minute. Although this would change slightly between trams. Whilst assessing this station, a tram was running late on platform one, which the tram driver appeared to not stop for as long. This is presumably to ensure that the tram can regain lost time.

At Cavill Avenue Station the information available was similar to the other two stations assessed. The information was also extensive as such the rating for this element was a two. Although given the size of the station and the number of patrons when a tram is due it may be difficult for an individual to be able to read the information. The information on the next tram was displayed over head on a digital display indicating the next two trams on that particular platform, and the direction they were headed either to Broadbeach Station or Gold Coast University Hospital Station. When the tram was one minute from coming into the station a voice over would indicate the platform and direction of the tram in one minute. As mentioned previously whilst assessing this station a tram was running late. This was communicated both through the digital display and through the voice over.

As with the other stations the timetable was not an official timetable but rather an indication of how often the trams run at different times and days of the week. The digital display would identify the time of the next two trams due at the station. The next station was displayed through a route map at the station which included all stations on the light rail network, this is shown in Figure 4.38 below.

Figure 4.38. Route map of light rail network.

The information available at this station also included a detailed map of the surrounding area. This included a radial of 400 metres surrounding the station or an approximate five minute walk, and 800 metres or an approximate ten minute walk. The information at this station was not available in multiple languages.

The ease to use the ticket machines at this station was similar to the Gold Coast University Hospital Station and Southport Station. The ease to use the ticket machines was rated a one. Each platform had a total of six go card points each. There were two ticket machines per platform which would accept EFTPOS, PayWave, and Cash. On platform one, one of the ticket machines was not working and would cancel the transaction without being able to purchase tickets. The ticket machines also seemed to cause difficulty for other patrons and were required to ask other individuals for help. Given the small size of the station and the number of patrons on the station, it may be difficult for people to purchase tickets if it were busy, particularly if the ticket machines are not working properly.

The ease to enter and exit the station was rated two. The design of this station means platform one on the west side was not separated by a road and directly onto the footpath. This meant that there were no crossings that needed to be crossed. The crossings over the tram tracks and

Surfers Paradise Boulevard were all signalised (refer to Figure 4.39). These crossings all had kerb ramps to be level with the road, with a crossing time of approximately twenty seconds. Although it was observed that many individuals did not wait for the right to cross, instead would cross when there was a break in the traffic. Individuals would also cross the tram tracks between platforms despite the sign indicating a fine applies if an individual crosses between the platform.

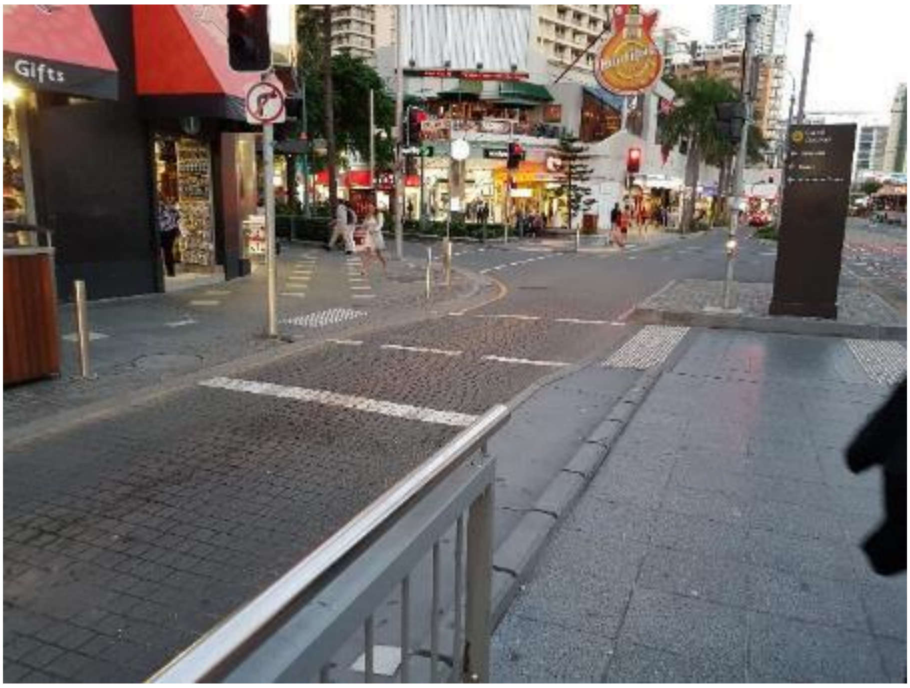


Figure 4.39. Signalised crossing at Cavill Avenue Station.

The seating provided at Cavill Avenue Station was rated a two. The seating capacity at this station was 16 per platform. In peak times when a tram was due soon the seating and platform would be full. Some of the seating was also littered with rubbish as seen in Figure 4.40 below.

Figure 4.40. Seating at Cavill Avenue Station littered with rubbish.

4.4.2 Bicycle Facilities

At Cavill Avenue Station the accessibility to the bicycle facilities were the worst of all three stations assessed. Firstly, bike racks were available approximately fifty metres from the station and were not easily located with no signage indicating their location or availability. Therefore, this element was rated a one. The usability of the trams was also rated one, as there were no facilities on board for bicycles. At peak times boarding with a bike may be impossible due to the number of people and size of a bike. However, the stations did provide a drinking water fountain with one per platform. The end-of-trip facilities was rated a zero as there were no facilities provided.

4.4.3 Elderly and Disabled Accessibility

The next factor considered was the accessibility for the elderly and disabled which was rated against the *Disability Standards for Accessible Public Transport 2002 Act.* For the boarding element, Cavill Avenue Station was rated a one. The horizontal gap between the light rail vehicle and the platform was approximately 50 millimetres, which exceeds the maximum required by the *Act*. Therefore, the *Act* requires that a boarding device be made available to those that require one to embark and disembark. The website indicates that one is available and if a user that requires one waits in the boarding assistance space the driver will assist the user. At busy times, this may be difficult for the disabled person to access and locate.

At this station, the allocated space was rated a two. This station has four allocated spaces per platform, with eight in total. Two per platform are at the boarding point which are 1400 mm x 1520 mm in dimensions and indicated through a blue wheelchair symbol. At the seating area there is also two per platform which is 1300 mm x 800 mm in size and indicted by black symbol. This symbol is more difficult to see as the black does not contrast well with the concrete.

At Cavill Avenue Station, as with the Gold Coast University Hospital Station and Southport Station, no signs had braille. Therefore, the rating for this element was a zero.

The tactile ground surface indicators were rated a two at Cavill Avenue Station. These indicators were installed to indicate the yellow line on both platforms. The indicators were provided at the signalised crossings. It was also used to indicate the change in height of the footpath.

4.4.4 Integrated Transport Accessibility

The Integrated Transport Accessibility of this station was assessed and rated a one. Cavill Avenue Station integrated with the active modes of transport walking and bicycling through the footpaths leading away from the station to the area surrounding the station. Whilst the buses did not integrate as well with Cavill Avenue as the buses did with Gold Coast University Hospital Station and Southport Station, various bus routes were available within a 400 metre or approximate five minute walk of Cavill Avenue Station. The station did not integrate with taxis, cars, or heavy rail. The Cavill Avenue Station promotes active modes of transport predominantly and for further destinations through the use of the bus network.

4.5 Physical Accessibility Data Analysis

The data analysis of the physical accessibility results will include the mean, median, standard deviation, and range. The graph in Figure 4.41 below shows the results of the data collection. The overall results were 21 for the Gold Coast University Hospital Station, and 19 for both Southport Station and Cavill Avenue Station. The stations of the Gold Coast light rail had the potential to be rated 30 for overall accessibility. The graph identifies the breakdown of these results into the following categories:

- General Facilities, up to a rating of 14;
- Bicycle Facilities, up to a rating of 6;
- Elderly and Disabled Accessibility, up to a rating of 8; and
- Integrated Transport Accessibility, up to a rating of 2.

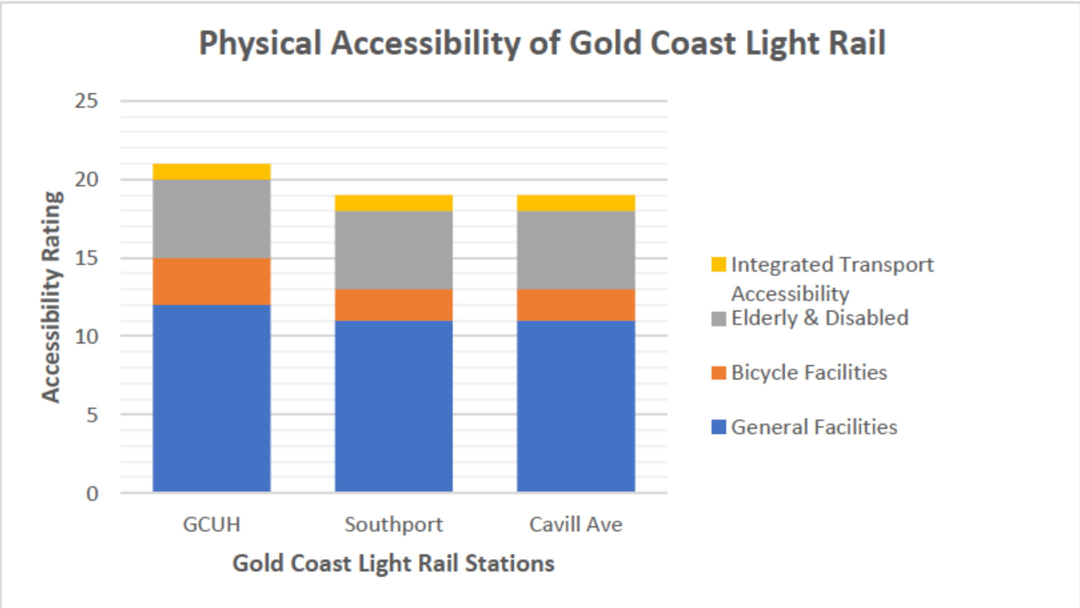


Figure 4.41. Physical accessibility results of Gold Coast light rail.

The mean results for the overall physical accessibility was 19.67, and the median was 19. For the general facilities the mean was 11.33 and the median was 11. The mean for the bicycle facilities was 2.33, with a median of 2. The mean and median for the elderly and disabled was 5.00. The integrated transport accessibility mean and median was 1.00.

For the standard deviation the total accessibility was 1.15. The general facilities and bicycle facilities standard deviation was both 0.58. With the standard deviation for the disabled and elderly accessibility, and the integrated transport accessibility a zero. These results coupled with the mean and medians and the total potential suggest some elements could be improved upon. This also suggests that the same elements were lacking for all stations.

The range of the data for the total accessibility was two. The range for both the general facilities and the bicycle facilities was one. The range of the data for the elderly and disabled accessibility, and the integrated transport accessibility was zero.

4.6 Social Accessibility

The results of the social accessibility for the different ticket types, using Equation 2.1 and 2.2 were as follows. For the Go Card adult, the calculated accessibility cost is $21.49 for one hour of travel, and expressed in time this would be 1.17 hours. The Go Card for a concession would cost $19.89 for one hour travel and in time of work required it was 1.09 hours. The paper ticket for an adult would be a total cost of $22.89 for an hour of travel, and in time this would be 1.25 hours. For the paper ticket for a concession the total cost for one hour of travel would be $20.59 and expressed in terms of time this would be 1.13 hours.

However, the total travel time of the light rail is approximately 33 minutes therefore the total cost, and travel time would be dependent upon the start and end of the journey, and whether any other means of travel are also used.

4.7 Conclusion

In this chapter, it revealed the results from the data collection undertaken on the Gold Coast light rail for both physical and social accessibility. These results revealed elements where the Gold Coast light rail is above average and areas where the accessibility is poor. The physical accessibility data was also analysed to reveal patterns of the results amongst the three stations assessed. The social accessibility results were lastly identified to indicate the accessibility of the Gold Coast light rail in terms of travel time and travel cost expressed both in monetary and time.

In the next chapter of this thesis, the discussion of the results will occur. This will include the relation back to the aims and research questions of this thesis. It will also include a comparison with the research identified in the literature review, and other light rail networks around Australia.

CHAPTER 5

5.0 DISCUSSION

5.1 Introduction

This chapter will discuss the results presented in Chapter 4. In the first three sections of this chapter the discussion will address the research questions guiding this research; physical accessibility, social accessibility, and integrated transport accessibility.

The focus of the chapter will then compare the results of this research to the findings in the literature review. Within this section it will include a comparison on the accessibility of other light rail networks around Australia.

The final section of this chapter will discuss recommendations to improve the accessibility of the Gold Coast light rail to its users.

5.2 Physical Accessibility

The first research question of this research was to determine the physical accessibility of the Gold Coast light rail to users. The physical accessibility was based upon the performance and level of service of the Gold Coast light rail infrastructure (Geurs et al. 2016).

In the previous chapter the results of the data collection were revealed. This identified the results of the physical accessibility for the three stations assessed. The results were 21 out of 30 for the Gold Coast University Hospital Station, and 19 out of 30 for both Southport and Cavill Avenue Stations.

To determine the physical accessibility score several different elements were assessed and rated based on their physical accessibility. This rating was 0 for no accessibility, 1 for average accessibility, and 2 for high accessibility. These are broadly categorised into the following:

general facilities, bicycle facilities, and elderly and disabled accessibility. Within each category were several elements including:

- General Facilities: toilets, ramps/lifts, ease to embark and disembark the light rail vehicles, information, ease to use the ticket machines, ease and safety to enter and exit the station, and the seating available at the station.
- Bicycle Facilities: racks, usability of trams, and end-of-trip facilities.
- Elderly and Disabled Accessibility: boarding, allocated space, braille on signs, and tactile ground surface indicators.

The completed accessibility forms of the above elements for each station can be found in Appendix B.

The results suggest that the physical accessibility of the Gold Coast light rail indicate further improvements could be made to improve the physical accessibility of the Gold Coast light rail.

The Gold Coast University Hospital Station scored for physical accessibility higher than the other two stations – Southport and Cavill Avenue Station. The main point of difference was that Gold Coast University Hospital Station had toilets available at the station, and there was a bike shed that was easily locatable with the capacity to hold a significant number of bikes. Whilst the other two stations had public toilets available, the toilets were at least a 400 metre or approximate five minute walk from the stations. This is considered to be less accessible given the distance required to access these toilets. Furthermore, the other two stations both had bike racks available. However, the capacity of these bike racks was minimal and not sufficient to hold the capacity similar to that of the Gold Coast University Hospital Station. Furthermore, these bike racks at Southport and Cavill Avenue Station were difficult to locate. At Cavill Avenue Station, the signage did not indicate the location of the bike racks. At Southport Station, the signage was not clear as to the location. At both of these locations the bike racks were located away from the station.

At Southport and Cavill Avenue Station the availability of space and the design of the station was poor. Each platform had two ticket machines available to purchase tickets, both were centrally located on the platform. However, the width of the station coupled with the number of people on the platform when the next tram was due during the peak hour meant that it was difficult to access these ticket machines. This means the accessibility of these two stations is dependent upon the number of individuals on the platform at a certain time. This may decrease accessibility at peak times. This factor of physical accessibility is considered to be particularly important given the promotion of its use during the 2018 Gold Coast Commonwealth Games. During this time, the light rail is expected to move thousands of people. It is difficult to improve the accessibility in terms of space, however improvements to the ticket machines could be made. This includes moving the ticket machines to the ends of the stations as opposed to the middle.

Despite the stations having accessibility issues for some of the elements, for others there was good accessibility. The availability of the information at the station provided information on the next two trams due for each station, and how many minutes until it was due, refer to Figure 5.42. The stations also had an informal timetable as indicated in Figure 5.43. The information also included a map of the surrounding area. These indicated what was available within a 400 metre or approximate five minute walk, and an 800 metre or approximate ten minute walk. This feature allows individuals to see the key points of interest and facilities available surrounding the station.

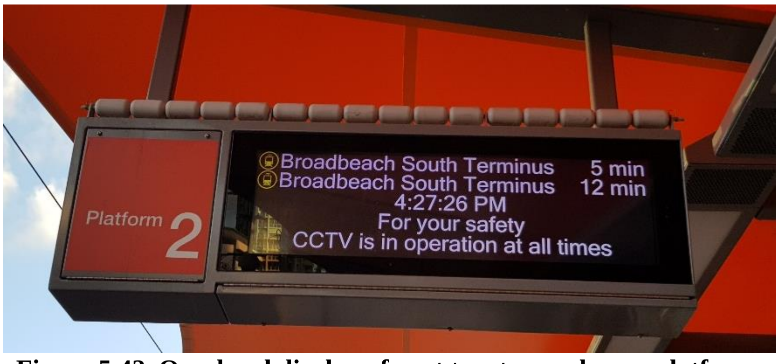


Figure 5.42. Overhead display of next two trams due on platform.

Figure 5.43. Gold Coast light rail timetable.

The access to the stations from the footpath was generally easy. Southport Station was designed to only allow traffic one way in a shared zone. This meant the pedestrian was given the right of way in that area (Geurs et al. 2016). At all points surrounding the stations signalised crossings were available. However, these were often disobeyed by individuals who would cross without the right of way, this occurred in front of trams and vehicles. This suggests a potential need to reconsider these crossings and the wait times.

The Gold Coast University Hospital Station was accessible to both Griffith University and Gold Coast University Hospital Station without the need to cross the road. This is through the use of the underpass available at this station. This is good in terms of accessibility as it means there is no need to wait to cross the road intersection. This also allows the two key destinations at this station to be equitably accessed. The station also has two lifts that allow access to both the university and the hospital (Ferrari et al. 2013; Zhou et al. 2012).

The accessibility of disabled and elderly users was a category as part of the data collection. The standard that this was assessed against was determining whether the stations complied with the *Disability Standards for Accessible Public Transport 2002 Act*. The boarding, allocated space, tactile ground surface indicators, and ramps all complied with the *Act*. The only issue for boarding was that the boarding device would be placed by the tram driver which may cause delays. Given that it is compliant with the *Act* it is considered to be accessible and at the appropriate standard (Disability Standards for Accessible Public Transport 2002). There was one element that the stations performed poorly for that was the braille on the signage. The signage at the stations did not have any braille. Although the wording of the *Act* indicates this is an optional requirement (Disability Standards for Accessible Public Transport 2002).

An element of the stations in particular Cavill Avenue and Southport Station was the use of ramps as the footpath and not using steps as seen in Figure 5.44. This suggests that those disabled, wheelchair bound, and blind commuters (DWB) were considered in the design of the Gold Coast light rail (Zhou et al. 2012).

Figure 5.44. Ramp based footpaths at Cavill Avenue Station.

Another category assessed was the bicycle facilities available at the stations. None of the stations had end-of-trip facilities available. At the Gold Coast University Hospital Station, there was a bike shed at street level with the capacity to hold approximately twenty bikes, the station also had water drinking facilities. At the two other stations, Southport and Cavill Avenue, there were bike racks with only a limited capacity of approximately four bikes, and water drinking facilities. At these stations, the bike racks were difficult to locate.

The light rail vehicles did not have the provision to take bikes on board, which can potentially limit the catchment area of users at either origin or end destination (Flamm et al. 2014). Given the stations also did not have adequate facilities particularly Southport, and Cavill Avenue

Stations, this can be perceived by bicycle riders that quality of the station is poor. This could potentially lead to lower ridership from bike riders (Geurs et al. 2016).

5.3 Social Accessibility

The second research question relates to the social accessibility of the Gold Coast light rail. Specifically, data was collected to determine the travel time and travel cost accessibility (the two key indicators of social accessibility used in this research) of the Gold Coast light rail system.

The results of the social accessibility revealed that it was more affordable for an individual to travel using a go card as opposed to using paper tickets. The fares considered were for both adults and concession fares. The results of this research question revealed the cost and time of travelling on the service for one hour.

Social accessibility is focussed on ensuring that all individuals have equitable access to public transport to allow individuals to reach a specific destination from their origin (Hawas et al. 2016; Lättman et al. 2016). It has also been suggested that those with the highest need for public transport – low socio economic, students, DWB – are often faced with the greatest barriers to accessing public transport, in particular the lowest provision of service (El-Geneidy et al. 2016).

From a socio-economic perspective, to measure the overall social accessibility of the Gold Coast light rail is another research thesis within itself. Therefore, this research was only aimed at determining the travel cost and travel time of the Gold Coast light rail, as one key element of social sustainability. This measure was developed by El-Geneidy et al. (2016), and is still a valid measure of social accessibility. Furthermore, within the physical accessibility, the accessibility for the DWB and elderly were considered. This can be considered social accessibility in a way, given that it was focussed on determining the level of accessibility and equitability (Mavoa et al. 2012; Zhou et al. 2012).

Currently the Gold Coast light rail is in the following Statistical Area Level 2 (SA2) suburbs: Southport North, Southport South, Surfers Paradise, and Mermaid Beach-Broadbeach (Australia Bureau of Statistics 2017b). In Table 5.13 below it identifies the median annual wage and population for each SA2.

Table 5.13. Median wage and population for SA2 areas of Gold Coast light rail (Australia Bureau of Statistics 2017b).

SA2 Area	Median Wage (annually)	Population
Southport North	$34,626	15,310
Southport South	$36,696	17,833
Surfers Paradise	$29,814	24,969
Mermaid Beach-Broadbeach	$41,944	12,653
Average/Total	$35,770	70,765

The Gold Coast light rail is only in zone 5 therefore the cost to travel along the route for one trip is the same regardless of which station an individual embarks and disembarks the light rail. However, given that the cost using the Gold Coast light rail is consistent it is therefore possible to determine affordability for each SA2 area.

For those within the Mermaid Beach-Broadbeach SA2 area given the higher median wage, it is more affordable in terms of percentage of income for those individuals to travel along the Gold Coast light rail. For those in the Surfers Paradise SA2 area, it costs more as a percentage of overall income than those in the other SA2 areas given the difference in income.

In Table 5.13 above it reveals that Surfers Paradise has the highest population yet the lowest median wage. This is for not only the four SA2 the Gold Coast light rail is within but also the wider Gold Coast local government. This suggests the SA2 with the most need from a social accessibility perspective is the closest to the Gold Coast light rail.

The median wage for the Gold Coast local government area is $42,108 with a population of 576,918, which is greater than the median wage of those near the light rail stations (Australia Bureau of Statistics 2017b). Therefore, it is possible to state that for those in the suburbs with the Gold Coast light rail, the cost of the light rail is possibly an important consideration in their weekly travel costs.

Those within the four SA2 included in Table 5.13 above have a combined population of 70,765 which represents 12.3 percent of the wider Gold Coast local government area. The average median wage for these four areas is $35,770. For the other SA2 the average median wage is $42,805 and accounts for approximately 500,000 people of the Gold Coast population. Therefore, from a social accessibility perspective this is beneficial for those within the four SA2 where the average median wage is less as these individuals have better access to the Gold Coast light rail.

The above analysis has revealed the social accessibility of the Gold Coast light rail compared with the wider Gold Coast region. However further research would need to be undertaken as the median wage has been largely generalised and may not reveal areas with low median wage that have no access to public transport. It also does not reveal the accessibility to all forms of public transport.

5.4 Integrated Transport Accessibility

The final research question was to determine the accessibility in terms of integration of the Gold Coast light rail system with other forms of public transport. This includes buses, heavy rail, cars, taxis, and active forms of transport including walking and cycling. According to Saghapour et al. 2016a the connectivity of a public transport system with other transport modes is one of the main factors to determine accessibility of a system. This research question was based upon the above consideration. Furthermore, research into accessibility of public transport systems identified the importance of walkability and bicycle access. Within these active transport modes, the main defining characteristic of accessibility is distance to public transport stops and stations which is between 400 metres and 800 metres (Dadhich & Hanaoka 2012; Geurs et al. 2016; Hawas et al. 2016; Mavoa et al. 2012; Vandebona & Tsukaguchi 2013).

The Gold Coast University Hospital and Southport Station are both considered to be bus interchange stations as part of the Gold Coast light rail network. At Southport Station, the bus interchange was an approximate 100 metres walk from the light rail station. Whereas the Gold Coast University Hospital Station, the bus interchange was located directly above at street level to the light rail stop. It is considered that the location of the bus stops at these stations is easily accessible, and integrates well with the Gold Coast light rail system.

Although Cavill Avenue Station is not a bus interchange station, a bus stop was still available within an approximate 400 metres walk of the station. A visual of the distances between Cavill Avenue Station and the nearest bus stop is shown in Figure 5.45. As such the integration of buses with the Gold Coast light rail is not considered to be the same as that of the other two stations assessed. Although it should be noted that Cypress Avenue Station to the north of Cavill Avenue Station is a bus interchange station. This is an approximate distance of 500 metres from Cavill Avenue Station. Therefore, users of the bus system and light rail system may be more inclined to be a user of Cypress Avenue Station. This is considered to still be highly accessible as bus stops should be available to all individuals within every 400 to 800 metres.

Figure 5.45. Cavill Avenue Station distances to other light rail stations and bus stops.

The current light rail network does not integrate with the heavy rail. Although works as part of stage two involve linking the light rail network with the heavy rail system at Helensvale. In Figure 5.46 below it provides a map of the heavy rail and light rail network both existing and planned for stage two on the Gold Coast. This will provide for the integration of the Gold Coast light rail with the wider south east Queensland public transport network which covers Brisbane, Ipswich, and the Sunshine Coast. Most importantly this integration will facilitate the expansion of coverage of public transport. The heavy rail network extends down to Varsity Lakes which follows the Pacific Motorway, and the light rail network currently extends to Broadbeach which follows the Gold Coast Highway.

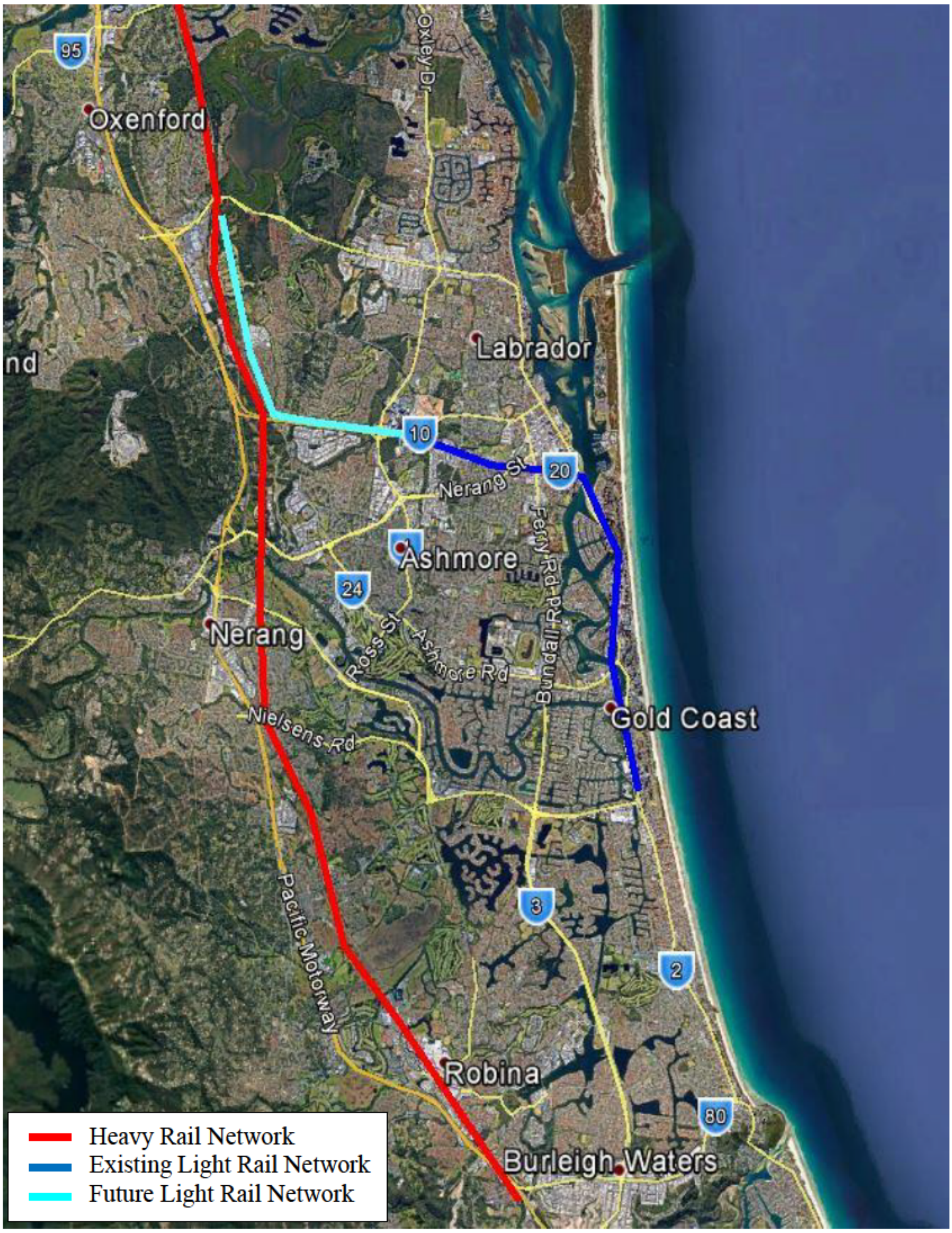


Figure 5.46. Gold Coast public transport map.

The integration of the light rail stops with active forms of transport including walking and cycling was highly accessible. The area surrounding the stations had pathed footpaths and where necessary provided signalised crossings to access key destinations. These key destinations were indicated through signage at the ends of the station, as seen in Figure 5.47 and Figure 5.48 below. The information board at the station also had a map which identified the surrounding area this is shown in Figure 5.49. Although there was signage to identify destinations, this was at times confusing for the author. One such case is the bicycle racks at Southport Station. The signage indicated this to be in an area where in fact it was not. The facilities at the stations included bike racks, although at Cavill Avenue and Southport Stations this was rather limited and difficult to locate in particular Cavill Avenue. All stations included several drinking water fountains. The stations were situated to ensure that they were centralised to the key destinations for each area, a map of each station is shown in Appendix D. In the immediate vicinity surrounding the station, the motor vehicle was removed or limited in access for that area. This facilitated safe access to the station platforms without the need to cross roads. This allowed for the integration of active modes of transport to be the highest priority.

Figure 5.47. Signage at Southport Station.

Figure 5.48. Signage at Cavill Avenue Station.

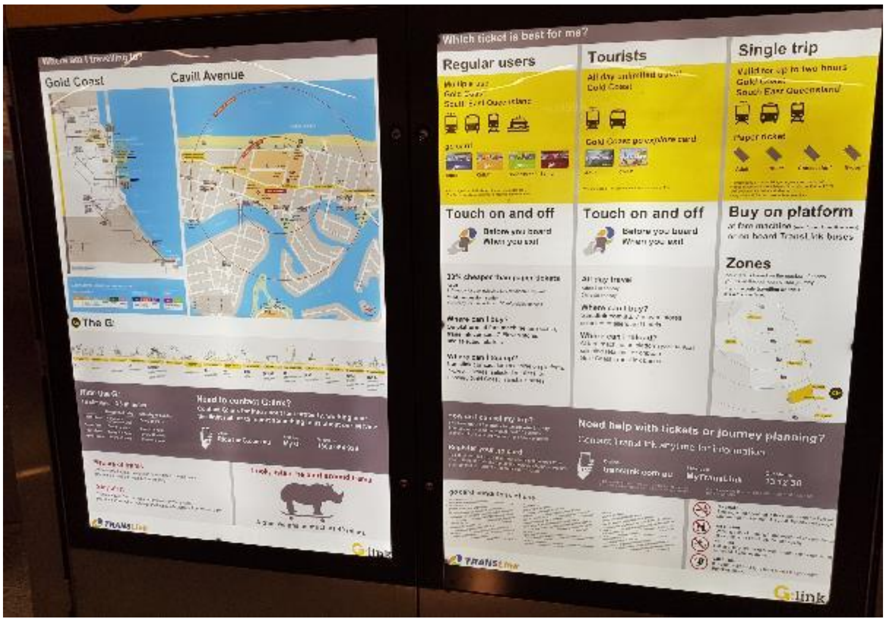


Figure 5.49. Information board at Cavill Avenue Station.

The three stations did not integrate well with the provision of taxis, as no stations had an official taxi rank. Therefore, an individual would be required to request a taxi to their location. This leads to poor accessibility for those requiring the use of taxis and light rail. At the Gold Coast University Hospital Station, the taxis were somewhat integrated through the taxi rank provided at the Gold Coast University Hospital. Although none of the maps of the surrounding area or signage indicated its location. Therefore, it is not considered to provide integration with the light rail network.

Most importantly is the lack of integration between the private motor vehicle and the light rail network. This includes the provision of drop off bays and long term parking. The three stations as part of this data collection did not have the provision for parking or drop off bays. This leads to poor accessibility as potential users will be more inclined to use their car for the entire journey due to the lack of provision for parking. Although it is important to note that not all stations would require the integration of parking with the light rail network given its location. For example, Cavill Avenue Station is located within the main tourist area of the Gold Coast, therefore, users of the network are more likely to walk from the station to their destination. Although for workers in the Cavill Avenue Station vicinity are less likely to use the light rail system given the lack of parking available nearby any station. Southport Station did have several car parks within a 400 metre walk of the station. However, these are mainly Council operated public car parks, that charge a daily rate to park. Therefore, users would be more inclined to use the motor vehicle as their form of transport as they may be required to pay for parking at their end destination. Whilst the light rail does not currently integrate at all with private motor vehicles, it is important to consider the location of the station as to whether car parking should be provided. This is due to not all stations having the need for car parking, such is the case for Cavill Avenue Station.

Overall the integration of the light rail with other forms of transport has been considered to be of average accessibility. This is due to some aspects of integration have been considered and implemented well with other aspects not as good. Previously it was indicated that public transport stops should be provided every 400 metres to 800 metres (Hawas et al. 2016; Mavoa et al. 2012; Vandebona & Tsukaguchi 2013). For the integration with bus stops at the light rail stations assessed the bus stop was available within a 400 metre walk. Therefore, it is considered that this element of integration performs above standard (Hawas et al. 2016; Mavoa et al. 2012; Vandebona & Tsukaguchi 2013). The local area maps surrounding the stations in Appendix D indicate that within an 800 metre there were several key destinations available. This includes various education, financial, employment, health, shopping, social, and recreational (Mavoa et al. 2012). These destinations are considered to be key destinations that individuals want to access using public transport, for the Gold Coast these include:

- Griffith University
- Gold Coast University Hospital
- Gold Coast Central Business District
- Australia Fair Shopping Centre
- Southport Community Centre
- Cavill Avenue Mall
- Various Gold Coast beaches, parks, and sporting facilities.

As these are all available within 800 metres of the stations, the Gold Coast light rail is thought to integrate above the standard (Mavoa et al. 2012). As part of the Gold Coast light rail, the stations did not include the provision of car parks at any of the stations assessed. The car parks would require utilising public parking on street or at off street Council car parks. This is suggested to not be at the standard as it does not promote multiple transport mode use. For heavy rail, even though it does not currently integrate there are alternative forms of public transport available within a 400 metre walk of the light rail station, predominantly buses. It is therefore considered to integrate with other public transport modes that is sufficient to the meet the standard (Mavoa et al. 2012).

5.5 Comparison with Previous Research

Currently in Australia, in addition to the Gold Coast light rail system, Melbourne, Sydney, Adelaide, and Dulwich Hills have light rail networks (Keys 2016). The light rail network at Melbourne has been the most researched network given its long operation length and extensive network at 250 kilometres (Currie & Burke 2013).

An important element of consideration of the Gold Coast light rail was the accessibility for DWB passengers and ensuring it complied with the *Disability Standards for Accessible Public*

Transport 2002 Act. From the data collection, it was found that the elements assessed were highly accessible for DWB passengers. However, the Melbourne tram system is faced with significant access issues, with most trams not accessible to those DWB individuals (Currie & Burke 2013). Despite the *Act* mandating that all public transport systems are required to comply with the standards within the *Act.* This change has not occurred on the Melbourne tram network mainly due to the significant costs (Currie & Burke 2013).

Another accessibility issue of the Melbourne tram system is the safety issues in accessing the tram vehicles. Passengers are required to wait at 1,200 of the total 1,800 kerbside stops as part of the Melbourne network and cross the generally busy road to access to the tram, as shown in Figure 5.50 below (Currie & Burke 2013). According to Currie and Burke (2013) this results in approximate 45 pedestrian and car accidents. The Gold Coast light rail has light rail stations that are defined and unlike the station shown in Figure 5.50. The Gold Coast University Hospital Station is entirely underground and can be accessed from Griffith University or the Gold Coast University Hospital without the need to cross the road. Similarly, Southport Station is located in a part of the street that is largely restricted from traffic. At this station, the pedestrian and trams are given right of way over cars refer to Figure 5.51 below. At Cavill Avenue Station, one way traffic occurs next to one platform at this station. With all stations, the surrounding pedestrian network is connected by signalised intersections to permit safe crossing.

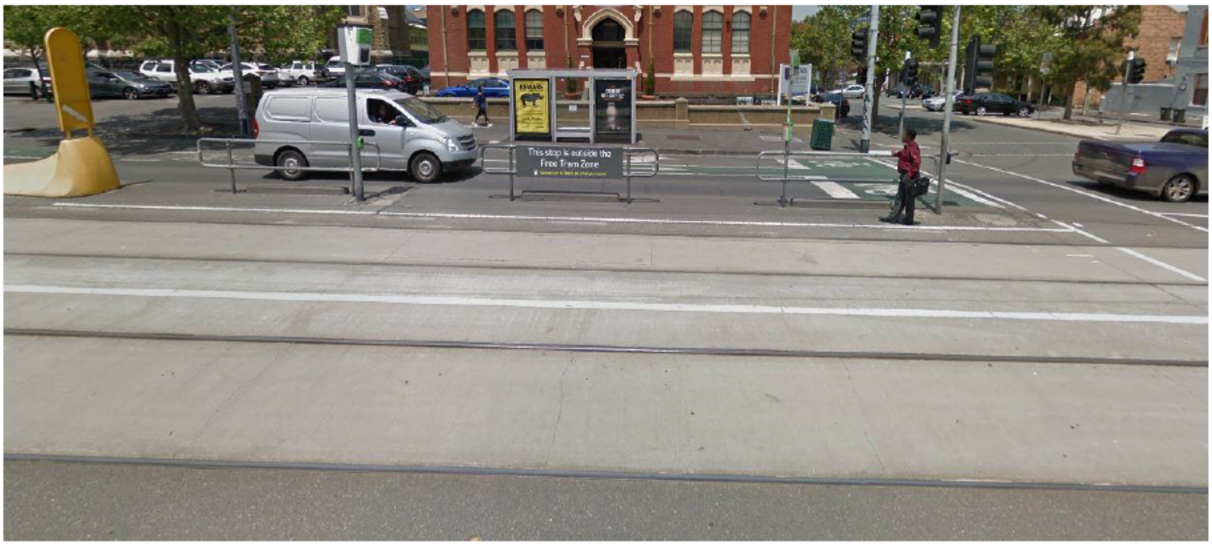


Figure 5.50. Melbourne tram stop in centre of road example (Google 2017).

Figure 5.51. Southport Station identifying safe pedestrian access (Google 2017).

An extensive public transport accessibility study was undertaken using the SNAMUTS measurement for each of the major cities in Australia (Curtis & Scheurer 2016). It aimed at finding the strengths and weaknesses of public transport systems. This method is not entirely similar to the methodology undertaken with this research, however, comparisons can still be made. The accessibility score was determined through assessing eight different factors of a public transport system with an overview provided in Table 5.14 below.

Table 5.14. SNAMUTS indicators overview (Curtis & Scheurer 2017).

SNAMUTS Indicator	Practical Example
Service Intensity	This indicator determines how many public transport vehicles are in operation per 100,000 residents. With the higher the number the greater access for residents.

Closeness Centrality	This indicator identifies the ease to access destinations using public transport. Cities that are more compact or with a faster public transport system are at an advantage.
Degree Centrality	This indicator reveals the number of transfers required between two destinations.
Network Coverage	This indicator is focussed on the number of residents that have walkable access to public transport within either 400 metres or 800 metres.
Contour Catchment	This represents the percentage of residents and jobs that are accessible by public transport within 30 minutes.
Betweenness Centrality	This indicator identifies service frequency and speed of a public transport system over a geographical area. Those with more services and faster speed that covers a larger percent of the population is more attractive.
Network Resilience	This indicator determines the ability for a public transport network to handle increased patronage. This is through the carrying capacity of a service on a particular travel route.
Nodal Connectivity	This indicator identifies the flexibility of the public transport network. This is determined by the number of services per hour on different modes.

For Melbourne, the accessibility score on average was 14.9 which is considered below average (Curtis & Scheurer 2016). Sydney which also has light rail scored a 13.2 accessibility index score which is considered to be of poor accessibility. Adelaide, the final city in Australia with an operational light rail system, had an accessibility index of 12.9 which is also considered to be of poor accessibility (Curtis & Scheurer 2016).

The abovementioned accessibility index was determined based upon the entire public transport network of a city as opposed to only the light rail system as it was with this research. Interestingly, the public transport in Australia is generally less than the standard to be considered average (Curtis & Scheurer 2016). Similarly, this research revealed elements of the Gold Coast light rail that did not perform well. Most notably the lack of large scale parking at the stations, the availability of toilets, and the limited accessibility for those that use bicycles.

5.6 Recommendations

The stations assessed as part of the data collection scored an accessibility rating of 19 for Cavill Avenue Station and Southport Station, and 21 for Gold Coast University Hospital

Station. This score had a potential to be 30 at its maximum. This suggests that improvements could be made to the Gold Coast light rail to improve its accessibility. In Table 5.15 below it identifies the recommendations as well as the agency responsible. In the discussion below it highlights only the key recommendations.

Table 5.15. Recommendations to improve accessibility of Gold Coast light rail and the responsible agency.

Recommendation	Responsible Agency
Bike racks: greater carrying capacity, in more locations with appropriate signage to identify their location	Gold Coast City Council/TransLink
End-of-trip facilities: change rooms, lockers, showers (potentially)	Gold Coast City Council
Bike-on-board facilities: have facilities on board to carry bikes to extend catchment at origin and end destination.	TransLink
Ticket machine: relocate to outer parts of station and change to make use of these machines easier	TransLink
Signage: improve signage to identify locations of facilities or destinations better.	TransLink
Disabled access information: more information on boarding device availability	TransLink
More employees available at stations	TransLink

For all the stations, the overall score for the bicycle facilities was generally low at either 2 out of 6 for Southport Station and Cavill Avenue Station, and 3 out of 6 for Gold Coast University Hospital Station. At all of these stations, this score was a result of the lack of end of trip facilities available at the station. These end of trip facilities could include change rooms, showers, lockers, drinking water facilities, and bike racks. At present the only bike facilities are the drinking water facilities, and the bike racks. Furthermore, Southport Station and Cavill Avenue Station at present do not have toilets to allow bike riders to use these facilities as a change room. These lack of end of trip facilities could potentially impact the bicycle ridership on the Gold Coast.

Another issue for all the stations, was the lack of bike on board facilities available. Given the amount of people utilising the light rail system at peak hours, it would be impractical to take a bike on board given the limited space. This could be improved through the provision of designated bike racks on board, with a certain boarding point, similar to that which is used for

DWB passengers. This has a potential to both increase bike and public transport ridership, and reduce the car usage rates.

For Cavill Avenue Station and Southport Station the bike racks at this station scored poorly at a 1 out of 2. There were several reasons for this poor scoring. Firstly, the bikes racks at these stations were limited to only approximately four bikes, refer to Figure 5.52 below. The lack of bike racks can potentially result in bike riders not using their bikes given the likelihood that the rider may be unable to safely secure their bike. Another issue was the location of these bike racks, at both of these stations the racks were away from the stations. It was also not easy to locate these bike racks as the signage and maps either did not indicate where the bike racks were as with Cavill Avenue Station. In the case of Southport Station, the bike racks were on all signage and pointed to different directions that made it difficult to locate. To improve the bike accessibility at these stations there are several practical elements that can be implemented. Firstly, provide more bike racks, that can cater a larger number of bikes, or alternatively, have a smaller number of bike racks but at several different locations surrounding the stations. This allows users from different directions surrounding the station to easily access the closest bike rack. Secondly, it is important to improve the signage to indicate the location of the bike racks currently. It may also be necessary to move the location of the bike racks to be closer to the stations platforms so that they are clearly visible to users.

Figure 5.52. Bike racks at Southport Station.

From a social accessibility perspective, by improving the bicycle facilities at the stations and on board the light rail vehicles, it can potentially extend the catchment area. This allows for a greater percentage of individuals to access the Gold Coast light rail.

At these stations, the go card facilities were well implemented, however, for those wishing to purchase tickets from the ticket machine this was potentially difficult. Firstly, the ticket machines were noted with having several issues of not accepting money, and often cancelling ticket purchase without processing. This often resulted in only one ticket machine on the platform being operational. It was also noted that many other passengers were unable to purchase tickets. This was further hindered by the fact that the stations did not have any TransLink employees on the platform. However, it is now indicated that from the beginning of August 2017, TransLink kiosks with employees will be open from 7am to 7pm daily to assist with any ticketing requirements at Broadbeach South and Cavill Avenue Stations (G:Link 2017). It is evident that TransLink is implementing steps to improve the accessibility of the ticket machines.

The ticket machines at these stations were located with two on each platform and centralised to the centre of the platform. This meant that during peak times when it was near to the next tram due, the platform became full of people. This resulted in these ticket machines being partially inaccessible given the number of people on the platform. This could be improved through relocating the ticket machines to the outer sections of the platform.

5.7 Conclusion

In this chapter, the discussion of the results revealed the elements of the Gold Coast light rail that are a good example of public transport accessibility. However, it also revealed that there were some elements where the light rail system did not meet the relevant benchmark.

Most importantly, it highlighted the need for further investigation, in particular for the integration of the network, once stage two works have been completed. It also identified an important piece of infrastructure to the wider Gold Coast public transport system through providing an important linkage along the Gold Coast Highway. This facilitates a greater carrying capacity of passengers as opposed to buses, which has the potential to greatly improve traffic congestion.

The final section of this chapter also provided comparison with previous research on other light rail systems in Australia.

CHAPTER 6

6.0 CONCLUSION

6.1 Summary

The aim of this research was to investigate the accessibility of the Gold Coast light rail system. The focus of this research can be briefly categorised into the following: physical accessibility, social accessibility, and integrated transport accessibility. This paper began with a background into the Gold Coast light rail, as well as a brief introduction into public transport statistics. The focus of this research paper then moved to providing a review of the literature on public transport accessibility and light rail networks, with specific case studies of light rail in Australia. This section also highlighted the different methods to carry out a public transport accessibility assessment. The next section identified the methodology for this project, including how the data was going to be collected, and why this method was chosen. The results of this data collection were then presented including an analysis of the results. These results were then used as part of the discussion of this project which also included recommendations to improving the accessibility of the Gold Coast light rail. This concluding chapter will include a summary of the findings relating to the objectives. The next section is for identifying future research beyond this research project. This chapter and this thesis will conclude with final comments.

The research identified the importance of considering accessibility of public transport to facilitate the increase in public transport ridership. The data collection carried out revealed the physical and integrated transport accessibility of the Gold Coast light rail. It identified elements to which this system performs quite well in and is highly accessible. But it also identified elements that are not as accessible and could be further improved.

The data collection revealed the potential limitations placed upon those who utilise or wish to utilise bike and the light rail as a dual mode of transport. These limitations relate to the lack of appropriate and sufficient facilities available at and surrounding the stations and on board the trams for bikes.

The accessibility for those with a disability or the elderly was considered to be equitable based on compliance with the *Disability Standards for Accessible Public Transport 2002 Act*. The allocated space provided is clear and allows those with a disability or elderly to clearly identify the allocated space.

The social accessibility objective revealed the cost of travel for using the Gold Coast light rail. This research question revealed the potential affordability of the Gold Coast light rail. However, it is important to mention that further research into the social accessibility would need to be undertaken. Furthermore, these transport costs and the affordability would also have to be compared with the cost of transport through private motor vehicle.

The abovementioned recommendations to the Gold Coast light rail system, specifically the bike facilities at the stations and on board can be implemented at a low cost to Government. By improving these bike facilities, it has been shown in previous research to improve public transport ridership. Most notably these improvements have the potential to greatly increase the catchment area for a station.

Through improving the current recommendations identified, as well as continuing to provide a high level of accessibility, the Gold Coast light rail has the potential to be a highly accessible and equitable public transport system with high levels of ridership.

6.2 Future Research

As the Gold Coast light rail has only been operational since July 2014, it is relatively new and the research into this system is rather limited. Furthermore, stage two of this system is projected to be fully operational in February 2018.

In terms of integrated transport accessibility, considering the works of stage two as part of the network, it will provide for a good light rail network, and provide the important link of the Gold Coast to the wider south east Queensland. These future works also include well thought out integration of car parking. Also considering the high level of integrated accessibility with active forms of transport of the existing network, stage two is likely to be highly integrated. Although further investigation into the network would be required to ascertain the integration with other forms of transport once operational.

The social accessibility is an important element of accessibility to ensure equitable access to all potential user groups. Further research beyond this thesis could investigate the social accessibility of the Gold Coast light rail, in particular the perception of accessibility to different user groups. This perception of accessibility is important to consider as it may reveal issues which can be rectified through simple changes to the light rail system (Lättman et al. 2016). The Perceived Accessibility Scale (PAC) was used by Lättman et al. (2016) to determine the perceived accessibility from public transport users in Karlstad, Sweden.

The results of these suggested future research works could be used to determine the accessibility of the Gold Coast light rail. This would allow those transport planners and policy makers to effectively implement changes to allow the Gold Coast light rail to become highly accessible. It also has the potential to increase overall public transport ridership, and decrease the reliance on motor vehicles on the Gold Coast. This could bring about a transport mode shift to the Gold Coast.

6.3 Final Comments

The literature on public transport accessibility has highlighted the importance for transport planners and policy makers to consider accessibility. Accessibility most importantly is identified as an important element to increasing public transport ridership. This results in a decrease in motor vehicle reliance which has several carry on effects including reduced traffic congestion, reduced greenhouse gas emissions, and increased levels of physical activity.

This research identified the accessibility of the Gold Coast light rail and found that the accessibility performs well currently, however improvements have been suggested. There are several factors which influence the individuals' decision to use public transport including being accessible through integrating with other forms of transport, being convenient such as being located centrally to the area, being safe, and having provision to be reliable. With the increasing need for public transport usage rates to increase to become the dominant form of transport over motor vehicles, public transport accessibility is an important concept transport planners and decision makers must consider when designing, implementing, upgrading, and maintaining public transport systems.

APPENDICES

APPENDIX A: PROJECT SPECIFICATION

ENG4111/4112 Research Project

Project Specification

For: Tammee Van Bael

Title: An Accessibility Investigation of the Gold Coast Light Rail System

Major: Urban and Regional Planning

Supervisors: Marita Basson, Michael Grosvenor

Enrolment: ENG4111 ONC – S1, 2017
ENG4112 ONC – S2, 2017

Project Aim: To investigate the accessibility of the Gold Coast light rail system.

Programme: Issue A, 9 March 2017

1. Research information relating to the public transport accessibility and their frameworks, ton light rail systems with focus on the Gold Coast system, and background information on the Gold Coast.

2. Develop a framework to be used to assess the accessibility of a light rail system using either one reviewed framework or a framework designed based on several reviewed frameworks.

3. Undertake the data collection using the framework identified in the methodology, and photographs, at the Gold Coast Light Rail on Gold Coast University Hospital Station, Southport Statin, and Cavill Avenue Station.

4. Analyse the data collected with a focus on the physical accessibility of the Gold Coast Light Rail system to its users.

5. Compare the results of the Gold Coast Light Rail system with other systems around Australia.

6. Provide recommendations on improving the physical accessibility of the Gold Coast Light Rail system to users.

If time and resources permit:

7. Analyse the data collected on the accessibility of the Gold Coast Light Rail system based on the service frequency and intensity.

8. Provide recommendations on improving the service frequency and intensity accessibility of the Gold Coast Light Rail system.

APPENDIX B: COMPLETED ACCESSIBILITY FRAMEWORKS

GOLD COAST UNIVERSITY HOSPITAL STATION

Form 1: Background Information	
Name:	Tammee Van Bael
Date & Time:	26/6/2017 3:43pm
Station Location:	Gold Coast University Hospital Station
Weather Conditions:	Fine, sunny
General Comments:	Station only partially operational due to Stage 2 works, only under ground station currently
Summary:	
Form 2 (General Facilities):	12
Form 3 (Bicycle Facilities):	3
Form 4 (Elderly & Disabled):	5
Form 5 (Integrated Transport Accessibility):	1
Total:	21

Form 2: General Facilities				
Toilets	Are there toilets at station?	Yes	No	Don't Know
	Condition of the toilets?	Good	Average	Poor
	Comments: x2 unisex disabled toilets, toilets were in average condition, rubbish on the ground			
	Rating	0	1	2
Ramps/Lifts	Are there ramps/lifts?	Ramps	Lifts	Nil
	Ramp Minimum Width?	N/A		
	Comments: x2 lifts near stairwell see map, no ramps			
	Rating	0	1	2
Ease to embark/disembark light rail vehicles	No. entry/exit points	8 (6 double, 2 single) per side		
	Height Difference?	50mm		
	Time to board?	3 mins		
	Comments: long board time as station is 'end of line' currently			
	Rating	0	1	2
Information	Next tram?	Yes	No	Don't Know
	Timetable	Yes	No	Don't Know
	Next Station?	Yes	No	Don't Know
	Map of surrounding area?	Yes	No	Don't Know
	Multiple Languages?	Yes	No	Don't Know
	Comments: multiple languages on door buttons			
	Rating	0	1	2
Ease to use ticket machines	Go card points?	6 per platform (6 operational)		
	Ease to purchase tickets? Some difficultly did not always accept payment and would cancel; noted that others had difficulty			
	Payment Options?	EFTPOS, PayWave, Cash		
	Comments: lots of go card points, one ticket machine not working, some others had difficulties			
	Rating	0	1	2
Ease/safety to enter/exit station	Type of Crossing:	Signalised		
	Time to cross at signalised?	25 seconds		
	Break in traffic at unsignalised?	N/A		
	Are there kerb ramps?	Yes		
	Lanes to Cross?	4		
	Location/Number of Crossings:	See map		
	Comments: at street level requires steps/lift to access from station, underpass can be used to access either side of street			
	Rating	0	1	2
Seating at station/light rail vehicles	Seating Provided?	Yes	No	Don't Know
	Capacity	16		
	Comments: one side of station not operational, bench at back used as seating			
	Rating	0	1	2
Total Rating				12

Form 3: Bicycle Facilities				
Racks	Are racks provided at stations?	Yes	No	Don't Know
	Location/Number?		x1 see map	
	Comments: at street level, not as easy to locate			
	Rating	0	1	2
Usability of trams	Bike on board facilities?	Yes	No	Don't Know
	Drinking Water facilities?	Yes	No	Don't Know
	Comments: water sprinkler provided on platform, near bike racks			
	Rating	0	1	2
End-of-trip facilities	Facilities provided:	Yes	No	Don't Know
	Location/Number?		N/A	
	Comments:			
	Rating	0	1	2
Total Rating				3

Form 4: Elderly & Disabled				
Boarding	Gap between vehicle and station?		50mm	
	Boarding Device?	Yes	No	Don't Know
	Comments: no translink employees at station, website indicates tram driver will deploy ramp for wheelchair bound			
	Rating:	0	1	2
Allocated space	Size? Boarding Point: 1400mm x 1520mm; Seating: 1300mm x 800mm			
	Number? Boarding x2 per platform; Seating x2			
	Symbol?	Yes	No	Don't Know
	Comments: boarding symbol blue and clear to see, symbol next to seating not as clear as it was black			
	Rating:	0	1	2
Braille on signs	Do signs have braille?	Yes	No	Don't Know
	Number?		N/A	
	Comments: entry/exit buttons have braille			
	Rating:	0	1	2
Tactile ground surface indicators	Indicators installed (access path: stair, ramp, direction change)?	Yes	No	Don't Know
	Locations? At yellow line, tram track crossing, lift entry, stairs			
	Comments:			
	Rating:	0	1	2
Total Rating				5

Form 5: Integrated Transport Accessibility			
Does light rail integrate with following transport modes?			
Taxis	Yes	No	Don't Know
Buses	Yes	No	Don't Know
Heavy Rail	Yes	No	Don't Know
Cars	Yes	No	Don't Know
Walking	Yes	No	Don't Know
Bicycling	Yes	No	Don't Know
Comments: bus stop at street level, pathways leading from station to surrounding area			
Rating:	0	1	2

SOUTHPORT STATION

Form 1: Background Information	
Name:	Tammee Van Bael
Date & Time:	26/6/2017 4:25pm
Station Location:	Southport
Weather Conditions:	Fine, Sunny
General Comments:	Good lighting, security cameras on both sides, people would risk crossing tram tracks between platforms even in front of trams
Summary:	
Form 2 (General Facilities):	11
Form 3 (Bicycle Facilities):	2
Form 4 (Elderly & Disabled):	5
Form 5 (Integrated Transport Accessibility):	1
Total:	19

Form 2: General Facilities				
Toilets	Are there toilets at station?	Yes	No	Don't Know
	Condition of the toilets?	Good	Average	Poor
	Comments: No toilets			
	Rating	0	1	2
Ramps/Lifts	Are there ramps/lifts?	Ramps	Lifts	Nil
	Ramp Minimum Width?	2000mm		
	Comments: platforms were designed to be at floor level			
	Rating	0	1	2
Ease to embark/disembark light rail vehicles	No. entry/exit points	8 (6 double, 2 single) per side		
	Height Difference?	50mm		
	Time to board?	1 minute		
	Comments:			
	Rating	0	1	2
Information	Next tram?	Yes	No	Don't Know
	Timetable	Yes	No	Don't Know
	Next Station?	Yes	No	Don't Know
	Map of surrounding area?	Yes	No	Don't Know
	Multiple Languages?	Yes	No	Don't Know
	Comments: door buttons in multiple languages			
	Rating	0	1	2
Ease to use ticket machines	Go card points?	6 per platfrom		
	Ease to purchase tickets? Some difficultly did not always accept payment and would cancel; noted that others had difficulty			
	Payment Options?	EFTPOS, PayWave, Cash		
	Comments: lots of go card points along platform, other passengers appeared to have difficulty purchasing tickets			
	Rating	0	1	2
Ease/safety to enter/exit station	Type of Crossing:	Signalised		
	Time to cross at signalised?	20 - 30 sec		
	Break in traffic at unsignalised?	N/A		
	Are there kerb ramps?	Yes		
	Lanes to Cross?	2		
	Location/Number of Crossings:	See Map		
	Comments: people ignored crossing times and crossed whenever particularly across tram tracks, platform linked will with both sides of street			
	Rating	0	1	2
Seating at station/light rail vehicles	Seating Provided?	Yes	No	Don't Know
	Capacity	24 per platform		
	Comments:			
	Rating	0	1	2
Total Rating				11

Form 3: Bicycle Facilities				
Racks	Are racks provided at stations?	Yes	No	Don't Know
	Location/Number?	See map		
	Comments: difficult to locate possibly far to out the way to be used			
	Rating	0	1	2
Usability of trams	Bike on board facilities?	Yes	No	Don't Know
	Drinking Water facilities?	Yes	No	Don't Know
	Comments: water sprinklers 1 on each side of platform			
	Rating	0	1	2
End-of-trip facilities	Facilities provided:	Yes	No	Don't Know
	Location/Number?	N/A		
	Comments:			
	Rating	0	1	2
Total Rating				2

Form 4: Elderly & Disabled				
Boarding	Gap between vehicle and station?	50mm		
	Boarding Device?	Yes	No	Don't Know
	Comments: no translink employees at station, website indicates tram driver will deploy ramp for wheelchair bound			
	Rating:	0	1	2
Allocated space	Size? Boarding Point: 1400mm x 1520mm; Seating: 1300mm x 800 mm			
	Number? Boarding x2 per platform; Seating x2			
	Symbol?	Yes	No	Don't Know
	Comments: boarding symbol blue and clear to see, symbol next to seating not as clear as it was black			
	Rating:	0	1	2
Braille on signs	Do signs have braille?	Yes	No	Don't Know
	Number?	N/A		
	Comments: entry/exit buttons have braille			
	Rating:	0	1	2
Tactile ground surface indicators	Indicators installed (access path: stair, ramp, direction change)?	Yes	No	Don't Know
	Locations? At yellow line, crossings, ramps, stairs			
	Comments:			
	Rating:	0	1	2
Total Rating				5

Form 5: Integrated Transport Accessibility			
Does light rail integrate with following transport modes?			
Taxis	Yes	No	Don't Know
Buses	Yes	No	Don't Know
Heavy Rail	Yes	No	Don't Know
Cars	Yes	No	Don't Know
Walking	Yes	No	Don't Know
Bicycling	Yes	No	Don't Know
Comments: see map for bus stop, bike racks			
Rating:	0	1	2

CAVILL AVENUE STATION

Form 1: Background Information	
Name:	Tammee Van Bael
Date & Time:	26/6/2017 5:01pm
Station Location:	Cavill Avenue Station
Weather Conditions:	Fine, sunny
General Comments:	Small station size, may not handle large crowd of people, particularly busy when next tram is due
Summary:	
Form 2 (General Facilities):	11
Form 3 (Bicycle Facilities):	2
Form 4 (Elderly & Disabled):	5
Form 5 (Integrated Transport Accessibility):	1
Total:	19

Form 2: General Facilities				
Toilets	Are there toilets at station?	Yes	No	Don't Know
	Condition of the toilets?	Good	Average	Poor
	Comments: No toilets			
	Rating	0	1	2
Ramps/Lifts	Are there ramps/lifts?	Ramps	Lifts	Nil
	Ramp Minimum Width? Platorm 2 Northern end: 1m, Southern end: 2m			
	Comments: Platform 2 ramps used to link the station level height with street level, platform 1 was same level as footpath no ramps needed,			
	Rating	0	1	2
Ease to embark/dis embark light rail vehicles	No. entry/exit points	8 (6 double, 2 single) per side		
	Height Difference?	50mm		
	Time to board?	1 minute		
	Comments:			
	Rating	0	1	2
Information	Next tram?	Yes	No	Don't Know
	Timetable	Yes	No	Don't Know
	Next Station?	Yes	No	Don't Know
	Map of surrounding area?	Yes	No	Don't Know
	Multiple Languages?	Yes	No	Don't Know
	Comments: button to enter/exit tram was in mulitple languages			
	Rating	0	1	2
Ease to use ticket machines	Go card points?	6 on each platform		
	Ease to purchase tickets? Some difficultly did not always accept payment and would cancel; noted that others had difficulty			
	Payment Options? EFTPOS, PayWave, Cash			
	Comments: plenty of go card points, at station 2 individuals asked for help with machine			
	Rating	0	1	2
Ease/safety to enter/exit station	Type of Crossing:	Signalised		
	Time to cross at signalised?	20 seconds		
	Break in traffic at unsignalised?	N/A		
	Are there kerb ramps?	Yes		
	Lanes to Cross?	1		
	Location/Number of Crossings:	3 (see map)		
	Comments: crossings provided it was observed many did not obey and crossed whenever a break in traffic			
	Rating	0	1	2
Seating at station/ligh t rail vehicles	Seating Provided?	Yes	No	Don't Know
	Capacity	16 per platfrom		
	Comments: seating and station at capacity in peak times when next tram is due soon			
	Rating	0	1	2
Total Rating				11

Form 3: Bicycle Facilities				
Racks	Are racks provided at stations?	Yes	No	Don't Know
	Location/Number?	See map		
	Comments: very difficult for author to locate, signage did not indicate bicycle storage			
	Rating	0	1	2
Usability of trams	Bike on board facilities?	Yes	No	Don't Know
	Drinking Water facilities?	Yes	No	Don't Know
	Comments: one water fountain per platform, no facilities on board for bikes, may not be possible in peak times to board with bike			
	Rating	0	1	2
End-of-trip facilities	Facilities provided:	Yes	No	Don't Know
	Location/Number?	N/A		
	Comments:			
	Rating	0	1	2
Total Rating				2

Form 4: Elderly & Disabled				
Boarding	Gap between vehicle and station?	50mm		
	Boarding Device?	Yes	No	Don't Know
	Comments: no translink employees at station, website indicates tram driver will deploy ramp for wheelchair bound			
	Rating:	0	1	2
Allocated space	Size? Boarding Point: 1400mm x 1520mm; Seating: 1300mm x 800mm			
	Number? Boarding x2 per platform; Seating x2			
	Symbol?	Yes	No	Don't Know
	Comments: boarding symbol blue and clear to see, symbol next to seating not as clear as it was black			
	Rating:	0	1	2
Braille on signs	Do signs have braille?	Yes	No	Don't Know
	Number? N/A			
	Comments: entry/exit buttons have braille			
	Rating:	0	1	2
Tactile ground surface indicators	Indicators installed (access path: stair, ramp, direction change)?	Yes	No	Don't Know
	Locations? At yellow line on both platfroms, at ramps, signalsed crossings			
	Comments:			
	Rating:	0	1	2
Total Rating				5

Form 5: Integrated Transport Accessibility			
Does light rail integrate with following transport modes?			
Taxis	Yes	No	Don't Know
Buses	Yes	No	Don't Know
Heavy Rail	Yes	No	Don't Know
Cars	Yes	No	Don't Know
Walking	Yes	No	Don't Know
Bicycling	Yes	No	Don't Know
Comments: nearest bus stop 250 metres away on Gold Coast Highway (see map), station integrates well with walking and bicycling			
Rating:	0	1	2

APPENDIX C: ADDITIONAL PHOTOGRAPHS

GOLD COAST UNIVERSITY HOSPITAL STATION

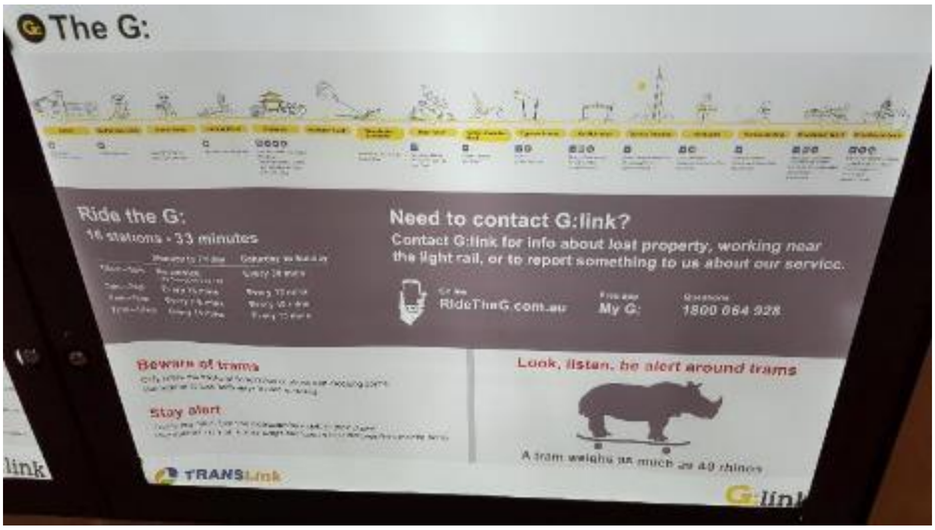


Figure C53. Timetable and stations of network, safety information and contact information.

Figure C54. Yellow line tactile ground surface indicators.

Figure C55. Tactile ground surface indicators at stairs.

Figure C56. Signalised intersection at street level.

Figure C57. Gold Coast University Hospital Station.

SOUTHPORT STATION

Figure C58. Tactile ground surface indicators at ramp.

Figure C59. Timetable for trams.

Figure C60. Signalised crossing and tractile ground surface indicators of kerb ramp.

Figure C61. Yellow line tactile ground surface indicators.

Figure C62. Tram track crossing with tactile surface indicators and yellow line.

Figure C63. Signalise crossing.

Figure C64. Water drinking fountain

Figure C65. Allocated space at seating.

Figure C66. Allocated space at yellow line.

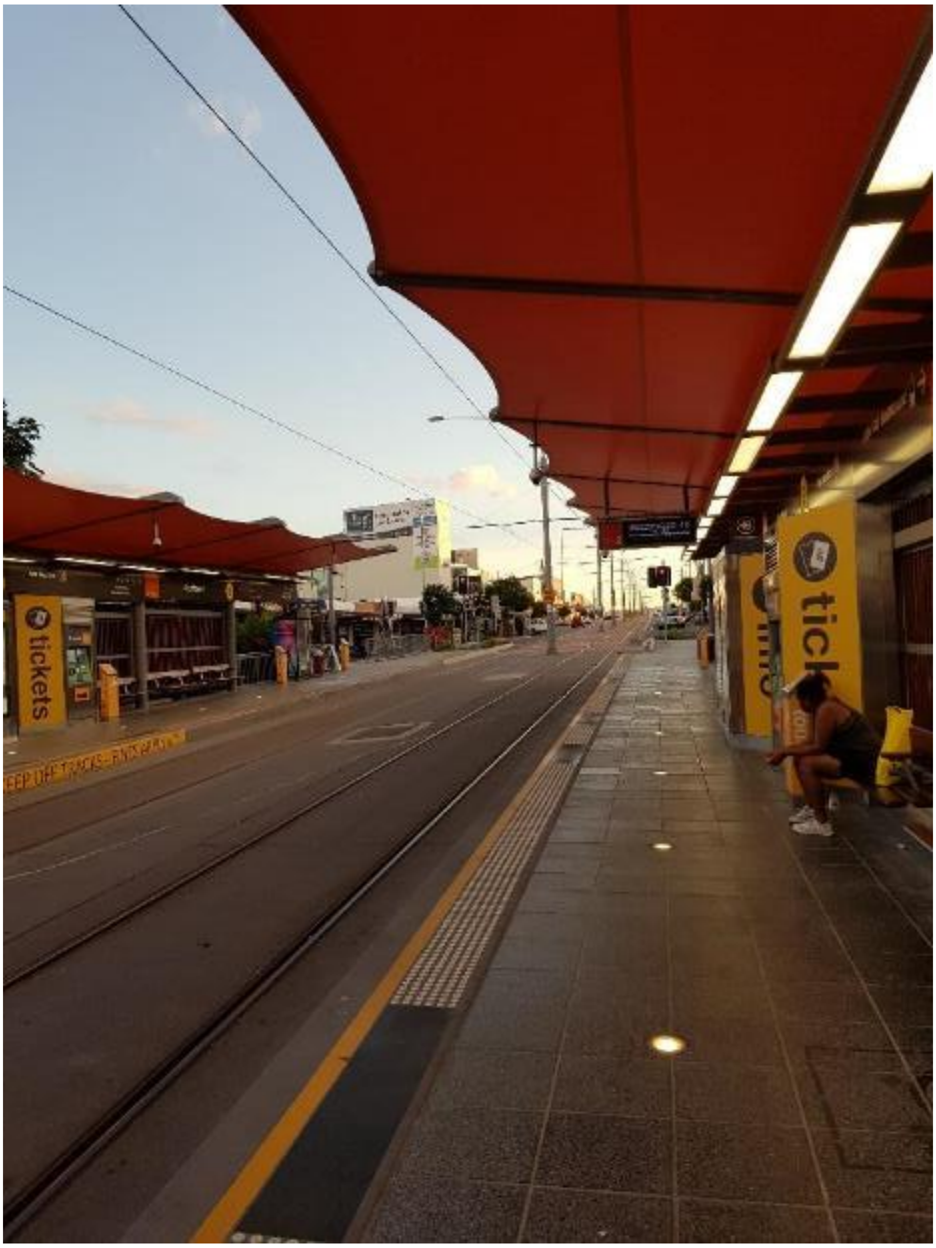


Figure C67. Southport Station.

CAVILL AVENUE STATION

Figure C68. Overhead display of next two trams due on platform.

Figure C69. Tram timetable.

Figure C70. Ticket machine.

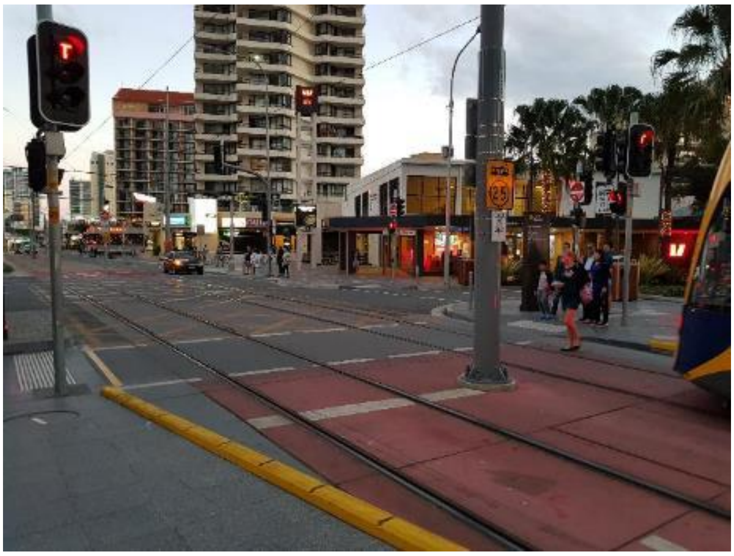


Figure C71. Signalised crossing with person crossing in front of tram.

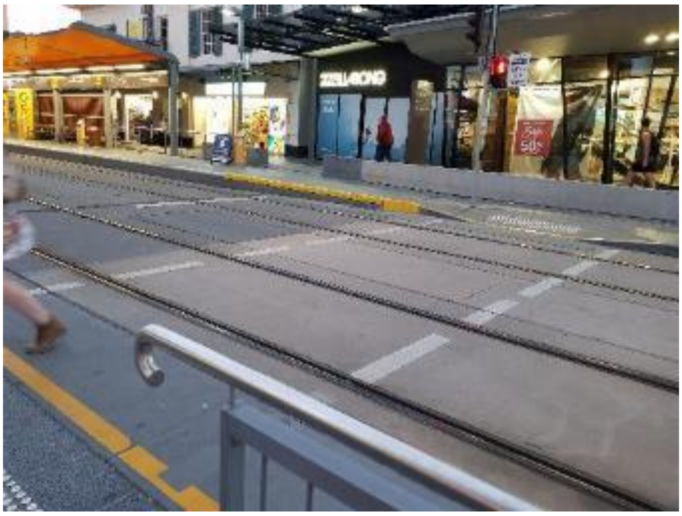


Figure C72. Signalised crossing at tram track.

Figure C73. Cavill Avenue Station.

Figure C74. Help and information point.

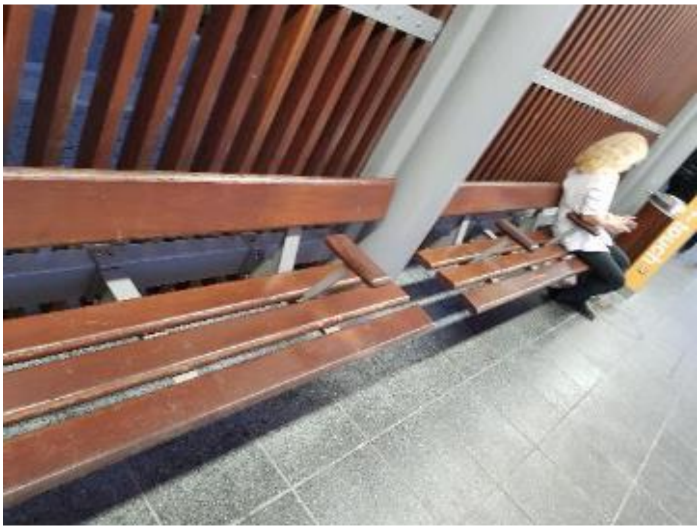
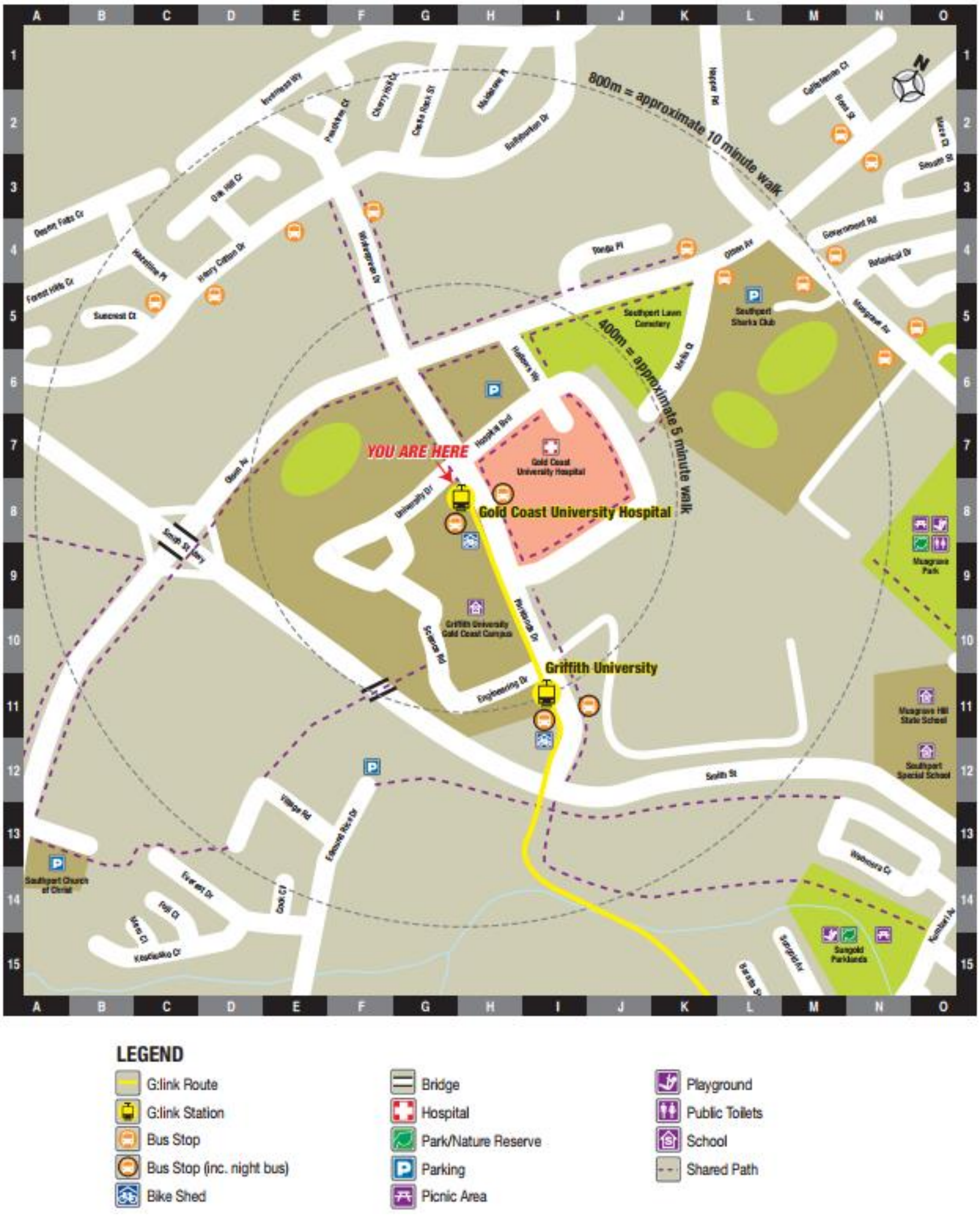


Figure C75. Seating at station.

APPENDIX D: STATION MAPS

Gold Coast University Hospital



Southport

LEGEND

- G:link Route
- G:link Station
- Bus Stop
- Bus Stop (inc. night bus)
- Bike Shed
- Hospital
- Park/Nature Reserve
- Parking
- Picnic Area
- Playground
- Police
- Public Toilets
- School
- Shared Path
- Shopping Centre
- Swimming

Cavill Avenue

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