THE CARTOGRAPHIC DESIGN AND USABILITY OF WHOLE-NETWORK BUS MAPS

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Good design looks right.

It is simple (clear and uncomplicated).

Good design is also elegant and does not look contrived.

A map should be aesthetically pleasing,

thought-provoking, and communicative. "

(Arthur H Robinson, 1995)

Abstract

This study represents an investigation into understanding the variation in bus map design and the impact of map design preferences in public transportation information portrayal. In many cities, bus services represent a vital facet of easing traffic congestion and reducing pollution. However, with the entrenched car culture in many countries, including Malaysia, the country targeted here, persuading people to change their mode of transport is a significant challenge. To promote this modal shift, people need to know what services are available and where (and when) they go. Bus service maps provide an invaluable element of providing suitable public transport information, but are often overlooked by transport planners, and are under-researched by cartographers. Although bus services are ubiquitous, much more attention has been devoted to metropolitan rail network maps (e.g. Ovenden 2003 & 2015, Roberts, 2012).

The earlier part of this study focuses on identifying the cartographic considerations when designing a bus map in a specific context. There are various approaches to the design of bus maps. It is a challenge for the authorities to understand which designs are preferred by the public and which perform best in conveying the required information. Even a quick look at a small sample of bus maps will show that there can be a significant variation in approach. This can vary from whole-network maps to single routes, and from geographically accurate maps to highly schematised representations. To advance the study and understand the cartographic styles of bus maps, it is necessary to develop a robust classification system that considers the critical factors in their design. The method employed was to examine a wide range of bus map examples from around the world, supplemented by considerations of other map classification systems and personal understanding of available options. The resulting classification is multi-faceted, but there are some apparent top-level differences in approach. One main distinction is between *Geographical Approach* maps and *Schematic* maps. While schematic maps are extensively used for metro systems, there are quite different considerations for bus maps and while some level of schematisation may be useful, highly schematic bus maps often present difficulties in everyday use.

While the earlier research phases identified the significant options in bus map design, to inform design choices, it is also essential to consider what users prefer and best promotes successful use. To help provide guidance, a map usability study was conducted during which bus users and potential bus users had to solve several journey planning tasks using two different designs of whole-network bus maps. The two different designs are the *Geographical Approach* bus map design and the *Semi-schematised* bus

map design. The distinguishing aspect of these two bus maps is only in their overall map design approach. Both maps have an identical bus route and bus information detail together with the same cartographic representation in terms of classification, symbolisation and typography.

While many of the findings have general relevance to all bus map use situations, the usability testing was carried out in Malaysia to ensure the findings were relevant to promoting bus use in that country. 100 respondents were involved in the map usability test. Cultural differences can be a factor in influencing map use performance and design preferences. The outcomes of the usability study were analysed statistically, starting with descriptive statistical analysis of all possible influencing factors of map preferences (independent variable data) like age, gender, travel habits, driving license availability, among others. These data were then cross-analysed with the findings from the map usability test, ranging from the respondent performance based on the correctness of an answer to their opinions about the maps. The analysis includes the ease of use while using the map, the confidence level in using the map and their map design preference.

The results show that the respondents prefer to use the *Semi-schematised* bus map design rather than the *Geographical Approach* bus map design. Their map preference's selection is well explained by their performance in the journey-planning tasks and subsequent answers to the questionnaire. The *Semi-schematic* design had a higher degree of task correctness than when using the *Geographical Approach* design. This degree of correctness that favours semi-schematic design shows the same pattern across all genders, ages, and travel habits, and is decisively supported by the confidence level ratings and ease of map use ratings. Interestingly, respondents across all age groups say they would be willing to make greater use of public transport if there were more of these kinds of maps available.

In conclusion, this research has brought much-needed insight into the public transport information provision of Malaysia's public transport systems. There has been lack of research in this field in Malaysia, and the findings from this study have highlighted the benefit of using the right cartographic technique to enhance public transport information provision and improve the use of the public transport system as a whole. Apart from the continuous improvement in physical aspects of public transport systems, a well-designed public transport map that balances the efficient cartographic technique with local cultural preferences. All these measures certainly can help authorities and public transport providers in encouraging the modal shift from the regular use of private cars to more frequent use of public transport systems.

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List of Abbreviations

ATCO	Association of Transport Co-ordinating Officer
BRT	Bus Rapid Transit
BSIP	Bus Stop Information Panel
ESRC	Economic and Social Research Council
GA	Geographical Approach
GIS	Geographical Information System
GPS	Global Positioning System
GTP	Government Transformation Programme
ICA	International Cartographic Association
ID	Identification Document
ISBSF	Interim Stage Bus Support Fund
LRT	Light Rapid Transit
MRT	Mass Rapid Transit
NKRAs	National Key Results Areas
OSM	Open Street Map
QCA	Quantitative Content Analysis
RK	RapidKuantan
SBST	Stage Bus Service Transformation
SDGs	Sustainable Development Goals
SPAD	National Land Public Transport Commission
UK	United Kingdom

Declaration of Originality

I declare that, except where explicit reference is made to the contribution of others, this dissertation is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution.

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CHAPTER 1

Introduction

1.1 Introduction

This chapter describes the basis and the framework for this research. The aims, objectives, and problem statements for the study are explained in detail here. Furthermore, this chapter also clarifies this project's vital scope, which is public transportation information provision, a research topic rarely visited by current researchers. Most of this chapter's contents are focus on the current issues and related knowledge surrounding the global public transportation system and the urgent need for useful public transport information.

1.2 Urban Transportation in Malaysia

Transportation is often referred to as the main component of cities and regions because it supplies the essential connection of constantly moving population in the area (Vuchic, 1999). In promoting sustainable regional development, the public and private transport must practically complement each other by developing a balanced, integrated system. Public transport usage has many advantages over the use of a private vehicle, including the benefits on energy conservation, environmental impact, community's social equality and the city's economy (Gronau and Kagermeier, 2007; Hutchinson, 2009; Redman *et al.*, 2013). The high percentage of private vehicle ownership in developed countries has turned public transport commuters into reluctant users. These commuters favour the use of private vehicle, which has led to increased accessibility problems, as reflected in the traffic congestion situation and parking spaces problem. Besides the congested road, private vehicles also caused other critical environmental issues such as increasing carbon dioxide pollution, global warming and noise pollution (Ojo, 2019).

It is essential to identify what is the basic quality factor of public transport services that could fortify modal shift from private vehicle to public transport. According to Borhan et al (2014), among the quality factors that have a significant influence in changing user transportation behaviour are safety, customer service, service reliability, and provision of adequate information of the bus route. The improvement of these service quality factors can affect the user's intention to use public transport through attitude. This continued improvement will then indirectly escalate the positive attitudes toward behaviour intention to use public transport.

In general, public transport will continue to play a crucial part in the commute of thousands of people and is a basic form of transportation across all regions. It is inconceivable for a country to reach the highest level of development without providing good mobility solutions. In Malaysia, public transport is dominated by bus services, which provides efficient mass transport in city areas. Buses also provide a good connection between the cities and other smaller towns and villages in rural areas. Buses provide the key transport option needed by people who do not have a car or access to a private vehicle. Malaysia's geographical and demographic factors shape the current situation of the public transportation system in Malaysia.

Malaysia has over 30 million people spread across two main geographical regions. The two main regions are Peninsular Malaysia (also known as West Malaysia) and Borneo (also known as East Malaysia). The South China Sea separates these two regions (Figure 1.1).

Figure 1.1: Map of Malaysia (retrieved from the Central Intelligence Agency (CIA), 2015)

In the last three decades, the Malaysian economy has turned from a more agricultural-based economy to manufacturing, engineering, and services. The changes in the economic environment have resulted in population migration into ever-growing cities and towns. According to the Ministry of Urban Wellbeing Housing and Local Government (2016), over 73% of the population currently lives in urban settings. This urbanisation rate is expected to reach 77.2% by the year 2020.

Widely influenced by the geographical aspect of its land, Malaysia’s primary transportation mode is by road. The road network is considered the most vital asset to connect a total land area of approximately 330,000 square kilometres. As such, the major public transportation modes available in Malaysia are bus and taxi. Long-distance rail transportation in Malaysia is limited to two main routes. The British Colonial era left Peninsular Malaysia with a rail line from Singapore to the Thailand border and Port Dickson (west side of the peninsula) to Kota Bharu (east side of the peninsula). This rail system has expanded significantly only around Kuala Lumpur and the Klang Valley area, with a light rail system, a monorail system (around the late ’90s), and the newly launched Mass Rapid Transit (MRT) system in 2017. With all this development, Kuala Lumpur and the Klang Valley region remained the only region with an advanced rail transportation system in the urban area. For areas outside of the Kuala Lumpur / Klang Valley area, there has been no development of rail systems other than the electrification of the double-track trail from the Thailand border to the Singapore Border. Completing this mega rail project is expected to enhance the rail commuter passenger system to travel between cities (intercity travelling) along the eastern side of Peninsular Malaysia. Other rail transportation megaprojects, such as the East Coast Rail Link (ECRL) and High-Speed Rail Project (connecting Kuala Lumpur to Singapore), are still in the early implementation phase, and it will be approximately five years before they are fully operational.

With no urban rail transportation on offer, the stage bus services remain the primary urban public transportation mode used in Malaysia’s major cities outside the Klang Valley area. The urban stage bus services for most cities in Malaysia have undergone a significant transformation since 2010. Previously, the state of urban stage bus services was in not good condition. The lack of coordination between urban stage bus services standards and operation methods resulted in low service quality, reliability problems, and service delivery issues. With the National Land Public Transport Commission (SPAD), several initiatives have been implemented in this critical public transport area. Among this initiative is a transformation program called the Stage Bus Service Transformation (SBST). This initiative enhances the stage bus services by rationalising the number of operators per route, implementing the Bus Rapid Transit (BRT) system, and enhancing bus stop facilities and guidance information. SPAD has created much-needed integrated and well-coordinated land public transport planning in Malaysia (National Land Public Transport Commission (SPAD), 2012). The commission has provided a comprehensive strategy for this transformation to achieve the vision of making public transport the people’s prime choice for mobility by the year 2030.

The urban stage bus services across all of Malaysia have benefited from SPAD's transformation programmes on current urban bus transportation systems (National Land Public Transport Commission (SPAD), 2016b). The delivery of the Stage Bus Service Transformation (SBST) programme, which operates under the *myBAS* brand, has helped sustain and revitalise these key stage bus service systems. It helps to maintain the connectivity and mobility for local commuters in every main city in Malaysia. The *myBAS* business model has ensured that the stage bus services system will maintain routes that are deemed crucial to passenger needs, even though they are not viable in terms of commercial considerations. Currently, *myBAS* services are yet to cover all the main cities in Malaysia. However, several main cities already have an excellent urban bus services operator under Rapid Bus Pte Ltd or better known as RapidBus. RapidBus is a subsidiary company of Prasarana Malaysia Berhad – a Government-owned Company which is also Malaysia's most extensive and leading public transportation provider. As of 2018, Rapid Bus provide the bus services in five key cities while *myBAS* currently provides bus services in another four cities.

As for the cities that are not covered under the Rapid Bus or *myBAS* programme, SPAD has delivered another stage bus services transformation programme under the name Interim Stage Bus Support Fund (*ISBSF*). The *ISBSF* has the same objectives as the SBST programme: improving the quality of existing bus services and continuing bus services on social routes deemed non-viable commercially (National Land Public Transport Commission (SPAD), 2016a). This is an interim measure before the application of the SBST programme in that area. Substantial funds are given to the current stage bus operators to cover their shortfall in providing the best stage bus services for their network area.

The main reason that the government funds these substantial programmes is that they will force the stage bus providers to give a consistent level of excellent service at whatever cost it takes to tackle the old negative perception among people towards public transportation in Malaysia. The public perception of users towards the existing public transport systems in Malaysia has declined over the years. This negative perception has caused low ridership for a long time in Malaysia. Before these initiatives, when bus ridership was low, the bus operators tend to cut down their services. The frequency of buses have often been reduced to 1 per hour, and to make it worse, sometimes the buses do not even turn up (Shahrim, 2015). This has built up negative feelings towards public transportation, and most people no longer trust public transport. The stage bus services will remain in place with these two-transformational programmes, despite low ridership on any routes. This will certainly boost the image of public transport and regain public confidence in the short term.

However, despite all these new government measures in recent years, public transportation usage in Malaysia is still relatively low and unsustainable, especially with the sharp rise of private car ownership in the past two decades (Chiu Chuen, Karim, and Yusoff, 2014). Low use of public transport and rising use of private vehicles indicate flaws within the current approach. The number of registered private cars increased by 41% from 2005 to 2010, and highway developments further intensify this situation into cities leading to traffic congestion (Azmi and Nor Fanim, 2012). Based on statistics of 31 December 2013, there were 11.03 million registered motorcycles and 10.48 million private cars, with a 35% increase in registered vehicles recorded between the years 2007-2012 (Azmi and Nor Fanim, 2012). These number are getting higher each year. In 2016, the number of registered motorcycles have increased to 12.67 million, and the number of private cars have increased to 12.99 million (Malaysia Automotive Institute, 2017). The private vehicle's average annual growth rate of 7.5% has surpassed the average annual growth rate of the population, which had an average of 2.25% in the same period (Indati, Ghate, and Leong, 2013). This has brought the level of Malaysia's private car ownership to exceed the level of wealthier western European countries and has caught up quickly with the United States of America and Australia, countries with a long history of car culture (Tong, 2014).

The issues surrounding the public transport system are growing in magnitude and further compounded by the flawed public transport information system's complexity. The challenges in transforming the public transport system into the mode of choice are not limited to increased infrastructure and capacity. A more integrated and comprehensive approach to delivering updated information and the currently available bus services networks is essential to enhance public perception and attract public transport use (National Land Public Transport Commission (SPAD), 2012).

1.3 Malaysia Urban Public Transport Legislation and Policies

In Malaysia, two national policies are affecting urban public transportation and plans. The policies are the National Key Result Area – Improving Urban Public Transport and the National Land Public Transport Masterplan.

1.3.1 National Key Result Area – Improving Urban Public Transport

Malaysia has set the year 2020 as the deadline to become a developed, high-income nation. Malaysia has already embarked on a plan to effect just such a transformation. At the heart of the plan is the Government Transformation Programme (GTP), an ambitious, broad-based programme of change to transform the government into an efficient and people-centred institution fundamentally. The GTP's structure is straightforward: areas that need the most attention are highlighted, and special treatment will be done in those areas. Through thorough and broader discussion with the main stakeholders, from the Ministries to the people, the Malaysian government, back in the year 2010, came up with seven stressed categorical segments that created what they called National Key Results Areas (NKRAs) (Malaysian Performance Management & Delivery Unit (PEMANDU), 2010).

GTP is a combination of several national Key Result Areas (NKRAs) with work individually. Still, through their combination of effort, the force generated by them is greater than the sum of its part. Each NKRAs segment is assigned to an area believed to have the most significant impact on the people. The seven NKRAs are:

1. Reducing Crime
2. Fighting Corruption
3. Improving Student Outcomes
4. Raising Living Standards of Low-Income Households
5. Improving Rural Basic Infrastructure
6. Addressing Cost of Living
7. Improving Urban Public Transport

The introduction of Improving Urban Public Transport as one of the NKRAs highlights the government's strong commitment to addressing the long list of issues that have plagued urban public transportation systems in Malaysia. The main objectives of this NKRA are to make urban public transport systems reliable, efficient, comfortable, and accessible with greater connectivity in all Malaysia's urban areas. Once all these objectives are achieved, and the systems have been improved, it is hoped that they can attract more people to choose public transport as their primary medium of transportation.

A fall in commuters using public transport can lead to a deficit in revenues for the public transport operator. The National Key Result Area – Improving Urban Public Transport (NKRA-UPT) has identified five principal levers to increase public transport usage. One of the principals is to stimulate demand to draw people to use public transport (Malaysian Performance Management & Delivery Unit (PEMANDU), 2011b). After years of being overlooked, the government acknowledges that information provision about public transport systems plays a big part. In their 2016 annual report, SPAD has stated that it is vital to make more useful information about public transportation systems accessible to all commuters. SPAD has launched a project called The Bus Stop Information Panel (BSIP). This project was launched to enhance bus services' perception and improve the accessibility of information about these services. The BSIP project plans to supply commuters with information about bus routes, route numbers, and service frequency.

Generally, almost all bus stations and bus stops in Malaysia have insufficient signage to give bus routes, frequency, and bus number (National Land Public Transport Commission (SPAD), 2016b). This kind of information is essential for commuters to know about bus services' current availability in any area to plan their journey swiftly. There are several bus route network maps on display, but such maps can only be found at main bus stations (one or two bus stations per zone). The situation worsens as the full bus route networks are not shown on any online websites. At other bus stops (and on the bus provider’s website), the bus service information is only offered in the form of thermometer maps, which is not the most appropriate way to represent the bus route visually, and certainly not the entire bus route network. A thermometer map can only show one bus route per map. This singular representation of the bus route has made the journey-planning process more challenging and confusing for commuters, especially when their journey requires them to change bus service several times before reaching their destination.

Regrettably, mapping information seldom gets a specific mention in any legislation. Even at the start of NKRA-UPT implementation in 2010, no particular action was highlighted about improving public transportation systems’ mapping information. All improvements are focused on the physical development of the systems. There is a lot of new infrastructure being built (new bus stops, new bus terminals, park and ride facilities), new routes being created to enhance connectivity across all urban areas, new ticketing systems, and more modern vehicles being acquired to raise the bus service image and reliability. Still, unfortunately, only minimal investment has been given to telling people about what is the all-new improved bus system is all about. Gibson (2009) stated that the information provided by maps is more desirable for journey planning processes. Nevertheless, only information in the form of destination lists (thermometer maps) is being made widely available to the users.

1.3.2 National Land Public Transport Master Plan

The National Land Public Transport Master Plan serves as a strategic document outlining macro policies and macro plans guiding the process of transforming the land public transportation landscape (National Land Public Transport Commission (SPAD), 2012). The masterplan aims to have 40% of all commuters use land public transport by the year 2030. Currently, the modal share of public transport in the Klang Valley Area is only 20% (National Land Public Transport Commission (SPAD), 2016b). Several policies have been developing around the crucial aspects of delivering accurate and effective information to the user.

One of the policies to develop a seamless experience for the user is Policy 3.5.3. This policy states that, beyond service quality and reliability issues, it is also essential that the commuter can conveniently get to the public transport node and to switch the mode of transport easily. The fragmented nature of the current public transport systems makes it difficult to plan one's journey effectively. Consolidating and communicating relevant public transport information to the public will be a key priority going forward. The move will increase the user-friendliness of the network and promote usage. A comprehensive passenger information system needs to be developed and embedded into upgrading efforts such as the bus stop enhancement measures to carry out this policy. A consolidated repository of public transport-related information, including route maps and timetables, is one of the passenger information systems' critical elements to make it easy for people to use public transport.

The public bus services will remain an essential part of the Malaysian Land Public Transport landscape because it gives the best transportation form to provide the first and last-mile connectivity. As such, many national transport blueprint plans have been produced to improve bus service systems' standards. One of the plans is the Bus Transportation Plan. The Bus Transportation Plan is one of the subsidiary's plans to achieve Land Public Transport Strategy for the National Conurbation. This master plan stresses the need to improve the bus information systems as one of its core initiatives. Better coordination of this core initiative is required to achieve high consistency and integration of the delivery structure. To ensure the transformation process delivers outcomes, all the techniques and solutions taken must engage land public transport users and operators in the input process to ensure that the transformation is people-centric. Commuters must be made a priority in every action taken.

The introduction of this masterplan highlighted the new direction taken to solve the city congestion problem. Previously, the improvement of public transport has not been a priority. The congestion solutions were focused on building more roads and providing more private vehicles to solve the increasing travel demand. The government has finally realised that mature cities cannot eradicate the congestion problem by building more roads. It is much more critical to provide more efficient and economically effective vehicles to cater to the travel needs of the people (Malaysian Performance Management & Delivery Unit (PEMANDU), 2011b).

1.3.3 Importance of Public Transport Information for Malaysian Bus Users

Malaysia has invested heavily in providing the best public transportation system possible, creating a favourable public transport policy, providing efficient vehicles, and building a world-class transportation infrastructure to support the system. However, the increase in people who use public transport in Malaysia is still low compared to the amount of time and money invested in this area (Manokaran, 2017). A study conducted by Zakaria et al. (2010) shows that negative perception has long plagued Malaysia's public transportation services. Users think that the public transport system is limited, old fashioned, lacking quality services, and small network area coverage.

To persuade users to change their perception of the system, they need to be informed and reminded about the current situation of public transportation. The first thing that comes to the user's mind when selecting the type of transportation they will use for their travel is whether their chosen option can help them reach their destination. It is at this point that the right public transport information matters the most. Previously, public transport advertising focused only on improving the public transportation system (bus terminal, bus stop, vehicle condition). Advertisements on some of the new upgraded systems were flooded with images and videos that showed new bus terminals, new bus stops, and modern vehicles used. Less attention has been paid to tell people about where precisely the buses go around their area. Here, they often find that the information available to them is minimal. This leaves them with a poor first impression of how public transportation service works.

1.4 The Need for Public Transport Information

Based on this situation, users always need to know all the critical information about the bus route network. The information is essential for them to plan and make their journey. The information given must be made very straightforward and convenient. Two types of information needed by the users come in the form of when and where. This information should be provided by the timetable and travel duration (when) and the bus route map (where).

The process involved in providing effective travel information must take the factors included in the route planning process as one of the considerations. The task of planning a route from one point to the other is a common wayfinding task (Golledge et al. 2000). It is important only to include information needed for the wayfinding process on the map. According to Brunyé et al. (2010), the route-planning process consists of three phases. The first phase evaluates the spatial relationship between origin and destination; second, selecting and correlating possible route options; the third is to choose the most efficient path (Bovy & Stern 1990). Based on these phases, all the additional information needed must be centralised on the route used as the bus's service routes, as the users will only focus their attention on these routes.

Research carried out by Transport Scotland (2017) found that existing bus users have often been left confused by poor and inconsistent public transport information. This problem has also affected the potential of future bus use from both current and future (potential) public transport users. All the stakeholders involved need to develop a uniform set of requirements used by all the parties to disseminate information about public transportation routes and timetables. A lack of understanding of the public transport system is a significant factor in why people use private cars rather than the bus system (Farag and Lyons, 2012). When information is poorly formulated and presented, the whole system will be viewed more as a complicated option to use rather than as a solution as it is intended to be.

Providing useful public transport information for wayfinding purposes continues to be essential as it provides support for the United Nation's Sustainable Development Goals (SDGs) (United Nations, 2015). People's movement from one place to another will consume resources, thus put it at the heart of SDGs on climate action (SDG 13) and sustainable cities and communities (SDG 11). An excellent public transport ecosystem also allows countries to achieve Reducing Poverty (Goal 1); Decent Work and Economic Growth (Goal 8); Industry, Innovation and Infrastructure (Goal 9); Reduced Inequalities (Goal 10); and Responsible Consumption and Production (Goal 12). With these connections to the SDGs, research on providing useful public transport information can firmly address multiple SDGs.

Norway exemplifies an excellent case of public transport that strengthens the SDGs. In Norway, an efficient public transport system has assured more employment, spurred economic growth, addressed Climate Change and environmental impact, and improved road safety. The number of people who use public transport in Oslo has significantly increased, even though number of car journeys has remained the same, which is a good indicator of the city livability and climate (The Explorer, 2020). Another good example can be cited from Singapore, Malaysia's neighbouring country. Singapore has indicated that public transport is the key economic factor for their country, and more public transport systems will be built to accomplish the objective bounded in the Land Transport Master Plan 2040 (Intelligent Transport, 2019). The CEO for Singapore's Land Transport Authority, Hoo Ping Ngien, welcomes any innovation and looks for any possibility of cooperating with companies to solve issues relating to public transport – including the innovation in the information provided.

Vehicles operating on conventional petrol, diesel, and other fossil fuels emit carbon dioxide. Carbon dioxide makes up 95% of all transportation-related greenhouse gas emissions (Hodges, 2010). Reducing these greenhouse gas emissions from the transportation industry could play a key role in combating climate change. People who use public transport rather than their private cars could contribute to reducing greenhouse gas emissions. An excellent public transport map design is needed to entice people to make more use of public transportation as it will make it easier for them to comprehend how the whole system works.

1.5 The Whole-network Bus Map Concept

There are several map forms used to visualize the bus system. Besides the whole-network map, other forms include those focusing on a particular route and the stop specific map. Route maps show one bus route (or perhaps a few per map) while the stop-specific bus map only shows the routes going forward from the specific stop or cluster of stops (Evans, 2010). The whole-network maps can be in either schematic, semi-schematic, or geographical form. A schematic map uses a certain distortion level in its map design, thus making it possible to draw an entire bus network in a single map without too much topographic detail and look more aesthetically pleasing to many users' eyes. Nevertheless, Morrison (1996) states that schematic maps are not convenient for bus maps as they not geographically 'true' and do not effectively show all the roads served by a route.

Understandably, a whole-network bus map design is still useful for travellers, as travellers still use the maps located on the wall of public transport stations while they plan for their journey (Hochmair, 2009). Whole-network bus maps are a good way to present all the bus route information. In only one picture, people can see the bus network coverage area and all the routes, which will help people who need to take multiple buses to reach their destination. They can see where to board and stop and where to change routes. However, this whole-network bus map needs to be designed carefully to achieve that purpose. With the high amount of bus information that needs to be included in the network map, there is a growing need to scale down complexity. This procedure helps users in extracting the information more effectively. The form of the maps is not up to the cartographer to decide, but should be determined based on the users' ability to extract information efficiently. All the bus station names and locations need to be well-defined with adequate background information. The background information includes an appropriate number of landmarks, other road name information, and the legibility of presented cartographic variables.

A whole-network bus map is a type of public transport map that is used to visualize all bus transportation routes in an area in one single map. The network map is different from a topographic map and other thematic maps. As the name suggests, whole-network bus maps are not exclusive to only one bus station or only one particular stop.

A whole-network bus map can be used and displayed at all bus stations and bus stops across the bus service area, and other locations. It is different from other bus map forms, like the stop-specific bus map or bus route map, made for only one bus stop or one route in the bus service area. These maps are made to complement the whole-network bus map and not to replace it. Economically, a whole-network map is cheaper to produce than to produce individual route maps for each route or stop-specific maps for each stop. The whole-network map consists of three types of information: background information represented by a point, line, and area symbology; transport station location represented by points symbology; and lines to represent the connection between these stations (Guo, 2011).

One of the primary roles of the whole-networks map is to represent all the available bus service routes currently in service in an area to the users. All the available routes will give users all the possible route choices to decide the best possible way to reach their destination. It will not limit the user's decisive action to choose only certain services being made visible to them, like being shown an optimised origin-destination map.

Bartram (1980) explained the concept of the Legibility of Public Transport Systems. According to Bartram, legible means that a user can go from one point to another in the easiest way possible without the concern of getting lost. The concept of legibility and being uncomplicated is the basis of this whole-network map research. A legible and uncomplicated whole-network map is essential in providing the users with a bus system that they can understand completely, contrary to what they feel is too complicated to use. By providing all the service route information to the users, it is expected to make users realise the full extent of the transport route network currently in service and available for them to use. This will be even more useful for a new user (new residents, tourists) to see the transport routes as more accessible as they may have a restricted cognitive map of their new surroundings.

Whole-network bus maps are expected to bring a few advantages from the passenger's point of view and the Local Authority's and Bus service operators' point of view. Local Authority and Bus service operators need a new measure to positively impact future patronage levels and bring much-needed impact on encouraging modal shift (more bus usage instead of using private vehicles). It is also crucial for this research to create a map that is easy to update with the latest route changes. Bus routes are different from the train, metro, or tram routes, as the alteration to bus routes can frequently happen at irregular intervals (due to various ad-hoc purposes). Finding the best cartographic template to make the whole-network bus map is the critical solution to this issue. The route changes will be made only to the affected routes, and redistribution of new maps can be done swiftly.

Furthermore, a whole-network bus map offers multiple usage capabilities. It is not only meant to be used and displayed at a bus station or bus stop. It could be used at various places such as the user's home or their office. This is because the journey planning process does not start when the passenger reaches the bus station or bus stop. It starts a soon as the person decides that they need to travel to a location beyond reasonable walking distance.

Nevertheless, every map design has its advantage and disadvantage. One negative aspect of the whole-network map concept is there can be a tendency to put too much information in one map, which may lead to user confusion. Whole-network bus maps tend to use topographic maps as the base of the map. Combined with the large paper size available, the vast free space always entices the mapmakers to include unnecessary spatial information during the map creation process. Understandably, the maps cannot consist only of information about the routes and the bus stops. Still, the map makers must consider what additional information can be put on the maps. If carefully selected, this additional information can help users determine their position and orientation (Bovy & Stern, 1990). Additional research needs to be carried out to determine the minimal level of background information needed by users to help them use the maps effectively as lack of background information would also cause a problem in some aspects of the map use process. One of the prevalent cases related to the lack of additional information in a whole-network map can be seen from the schematic London Underground Map, designed by Harry Beck in 1931. This map may have gained iconic status due to its unique map design principles, but lack of additional background information can raise users' issues regarding the actual journey length between some of the stations on the map (Vertesi, 2008).

1.6 Availability of Bus Maps in City of Kuantan, Pahang

The task of providing public transport information in Malaysia is solely under the bus operator's responsibility. In the City of Kuantan, RapidKuantan is the sole stage and city bus operator since 2012. There were various bus operators, but the other bus operators did not manage to survive due to the ineffective business model. The Malaysia Federal Government, under its public transport corporate body, Prasarana Malaysia Limited, took over the whole stage bus provision in Kuantan to help revive the ailing bus service.

Prasarana Malaysia, under the RapidKuantan brand, launched its operation on 1 December 2012. In 2016 the RapidKuantan had a fleet of 80 buses and operated on 15 different routes over two districts in the State of Pahang, Malaysia. Figures below (Figure 1.2 to Figure 1.12) show the current mapping information available to the users in regional areas surrounding Kuantan, Pahang.

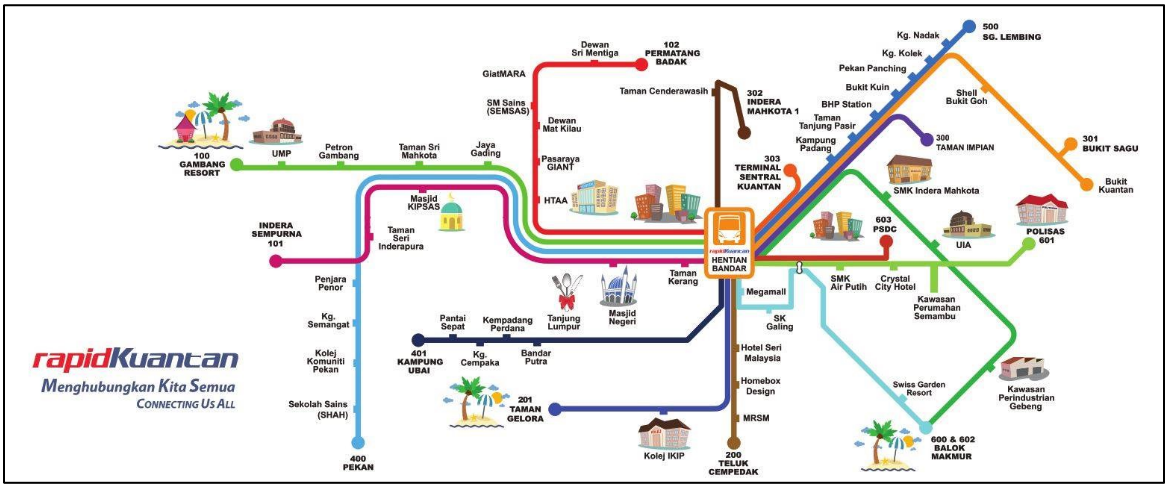

Figure 1.2: The whole-network bus map of Kuantan, Pahang (source: RapidKuantan, 2016)

Figure 1.2 shows the first and the only whole-network bus map published by RapidKuantan. This network map can only be found at the Main Bus Station in the city centre. It is not available on any online platform. The map was created initially during the launch of RapidKuantan in 2012. Despite the change in bus routes over time, no update has been made to the map.

RapidKuantan did announce a change in bus routes through the publication of new individual route maps, as shown in Figure 1.3 to Figure 1.8. The maps were only published on the official company Facebook and Twitter pages, but no printed versions were made available. The maps were created by simply drawing lines and text placement onto a screenshot of background graphics taken from various online sources. There was no uniformity in terms of the width, size, and the colour of the lines used to present the bus service routes. Furthermore, no serious consideration has been made in terms of every map element shown, including the landmark number and placement, the variation in graphic variables, the use of colour, the typography setting or the presence of a legend.

Figure 1.3: Individual bus route map (Route 402) (source: RapidKuantan, 2016b)

Figure 1.4: Individual bus route map (Route 300 and 303) (source: RapidKuantan, 2016c)

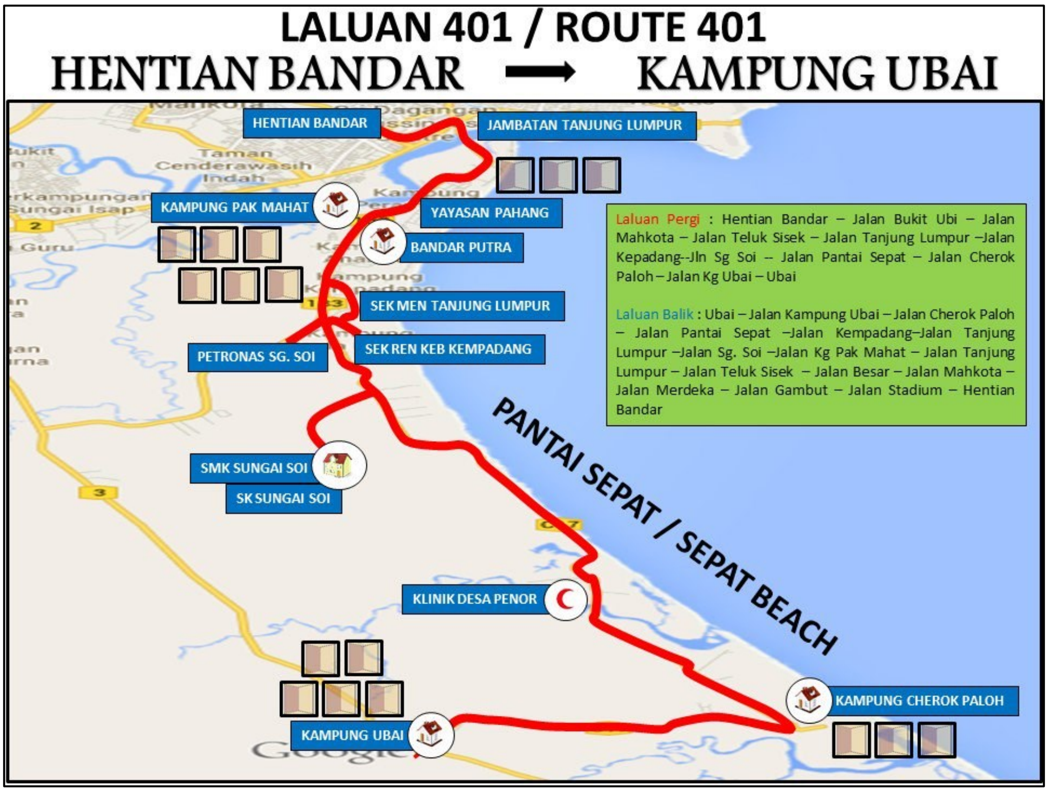

Figure 1.5: Individual bus route map (Route 401) (source: RapidKuantan, 2015)

Besides the above maps, RapidKuantan did keep publishing new maps to inform the users about their current bus route services. However, the non-uniformity of the cartographic style continues to be an issue here. Maps for bus route 601 (Figure 1.6) and bus route 201 (Figure 1.7) shared a similar basemap and other graphic variables. However, a map created for bus route number 201 (Figure 1.8) uses a different type of basemap and presents less geographical information than other maps that have previously been published.

Things get worse if we examine the other visual variables and typography representation in the map. Moreover, there is no proper judgment in terms of text labelling and text placement. The text presented is either too small or of low quality to read much of the maps' detail. The maps were published in a low resolution, making it hard for any user to read the map's information.

Figure 1.6: Individual bus route map (Route 601) (source: RapidKuantan, 2014)

Figure 1.7: Individual bus route map (Route 201) (source: RapidKuantan, 2014a)

Figure 1.8: Individual bus route map (Route 401) (source: RapidKuantan, 2015)

As for the other available mapping design, only information in the form of thermometer maps is provided. This type of information was made widely available and can be found at every bus stop and bus station. In this thermometer map (see Figure 1.9 to Figure 1.12), only the central bus station's name and the bus stops involved in the specific route are shown. No other geospatial information is included in the information board. As the bus stations' (stops') naming convention is not as good as the ones provided by rail systems, people may be confused by the same name of bus stop at different locations on totally different bus routes. Presenting bus information in these singular maps (one bus route per map) will probably create more confusion than solve a problem (Tyner, 2014).

Figure 1.9: Thermometer maps located at a bus station in Kuantan

Figure 1.10: The thermometer map design placed at a bus station in Kuantan (Source: RapidKuantan, 2012)

Figure 1.11: Thermometer maps located at a bus stop in Kuantan

Figure 1.12: The thermometer map design placed at a bus stop in Kuantan (Source: RapidKuantan, 2012)

Nevertheless, users that need to take only one bus route to complete their journey might find this type of map useful. It will be a challenge for users that need to take several buses to complete their journey. In this case, the user needs to combine multiple route maps to plan their bus journey. Lack of bus stop locations and bus station names on these maps will make it harder for the users to know where to stop and board another bus along the journey. Providing this type of information in the form of paper maps or booklets will not help significantly as they will probably form part of a substantial and complex document. People may continue to be confused while trying to match the routes that need to be taken along the journey.

Clearly, Kuantan's bus map information provision is in an unacceptable condition. This provision of information and the contents need to be improved. Providing better information and better maps is one of the most efficient and probably the most cost-effective ways of improving bus transportation information provision (Zegras *et al.*, 2015). It is the quickest way for the public authorities to tackle changing the way people travel and move away from their private vehicles.

1.7 Problem Statement

Public transportation is a cornerstone of a nation's economy. Its availability and convenience define quality and promotes positive perceptions of public transport services. Presenting a whole-network bus system in one systematic map helps users' route planning across a region. With one map, the user can decide the best bus route that they should take to reach their destination. However, this type of whole-network bus map can be a challenging product to use. By showing routes of all services provided by all the bus companies across one specific area, it can prove difficult for some users to engage correctly with it. Therefore, any way of improving the design is likely to have benefits.

The need for well-integrated and comprehensive whole-network maps as part of bus information provision is crucial as a basis for user's analysis and decision making. A lack of maps or having a poor map with confusing and complicated information will lead users to ignore bus services as one of their travelling options. The previous section highlights the need for public transport information in the research area from every perspective: the passengers, the public transport operators, and the public authorities. Public transport information provision has a crucial impact on lifting the public transportation image, similar to improving the public transport infrastructure, management, and any other physical improvement. Good information helps users understand the currently available public transportation services. It will make it easier for them to complete a journey using the public transportation system. As for the relevant authority's perspective, the failure to see this type of public transportation information picture will lead to public funding being channelled to waste rather than the effective use of the infrastructure.

1.8 Research Questions, Aims, and Objectives

1.8.1 Research Questions

1. What are the cartographic representation techniques and design styles used to visualize the bus transportation system?
2. How effective is a new whole-network bus map design in assisting bus users in planning a bus journey in Malaysia?
3. Which type of whole-network bus map design is preferable to the bus users in Malaysia?
4. Will a new whole-network bus map promote and encourage further bus usage in Malaysia?

1.8.2 Research Aims

This research aims to investigate one of the potential flaws that contribute to low public transport use, which is the lack of effective whole-Network public transportation maps and whether a new version of systematic whole-network mapping can eradicate user's confusion during the journey planning process when they plan to travel by bus around their local area. Providing such information will make it much easier for the users to understand what the full-service provision offers them.

The improved whole-network bus map system should expose the users to all the choices that they can take to reach their destination from their current location in the shortest period. This research should also encourage the users/commuters to use the bus transportation system and give a significant boost to the relevant authorities to use maps based on planning and resource allocation decisions.

The objectives of this research are as follows:

1. To carry out a comprehensive review of current and recent bus map design.
2. To identify the cartographic representation techniques that appropriately visualise and enhance the bus transportation system, and establish a view on bus mapping's best cartographic practice(s).
3. Based on the above review, design and produce prototype whole-network bus maps of the study area.
4. Conduct a map usability study on the prototype bus maps.
5. While conducting the map usability test, to gather additional information about the potential of whole-network bus maps to encourage bus use.

6. To provide recommendations on the production and distribution of maps and how they can improve the public transport system as a whole.

1.9 Thesis Structure

There are seven chapters presented in this thesis.

- Chapter 1: Provides the introductory explanation and the study's basic framework around public transportation information provision. This introduction includes a description of the aims, objectives, problem statements, and research questions. The issues and related knowledge surrounding Malaysia's public transportation systems are also discussed here.

- Chapter 2: Provides a comprehensive review of current literature related to various issues surrounding Public Transport information, emphasizing the mapping provision. The needs and the benefit of having good transport information are discussed, followed by a thorough review of several essential aspects of public transport information provision, which includes knowing the user perspectives and ability to use maps, the cognitive mapping concept, the diverse styles of bus mapping techniques and the principles behind map usability test.

- Chapter 3: Presents the deliverables from the earlier phase of this study, the cartographic design review of the current bus maps. The assessment consists of a map critique part that focuses on identifying the good cartographic design features of existing public transportation mapping practices that could be implemented to design the maps for this study's further stage.

- Chapter 4: Describes the research methodology used in this study. In this chapter, this study's conceptual framework, which is developed from the User-Centred Design (UCD) theoretical concept, is explained. The chapter then discusses and describes the test material, the test instrument, and the sampling methodology. The explanation of the selection of the study area is included here.

- Chapter 5: Explains the processes involves in designing the map prototypes. For the map design process, all the cartographic specifications selected in designing the new bus maps are clarified. An explanation of the map usability test is given, along with an overview of the field test procedure

- Chapter 6: Presents the field tests' results and analysis to evaluate the potential impact of the bus users' whole-network bus map concept in the study area. A summary of sample profiles is shown, followed by a comprehensive analysis of various aspects of the map usability testing to compare the performance and user preference of both forms of the network maps involved. Discussion about the potential future use of the preferred plan is included at the end of this chapter.

- Chapter 7: Provides the study conclusions, outlining the significant findings, and makes recommendations for future research work related to this study domain.

CHAPTER 2

Public Transport Information: Provision, Use, and Usability Research

2.1 Introduction

There are relatively few reported studies in the field of bus mapping and bus map information provision. This chapter reviews these studies, and more general literature on various issues related to public transport (PT) information, emphasizing the mapping provision. As well as providing context for the current study, the objective of this chapter is to highlight the need for more research in the field of bus mapping.

This chapter starts with a discussion about the needs and benefits of public transport information. Then, the discussion continues in reviewing various issues surrounding public transportation mapping. The review includes the discussion on public awareness and attitude towards the usage of public transportation, people's ability to use a map, the government policies on bus transportation systems, and other relevant topics. The principles behind map use and map usability test design are also discussed here.

2.2 Public Transport Information Provision

To materialise the modal shift in public transportation usage, Lodden (2002) has stressed that public transportation systems must emerge as a complete and adequate system. This is regardless of how complex the passenger's journey, how far the distance travelled, how familiar they are with the transport system and how many public transport providers operate at a particular place. Limited or non-availability of service information should not impede people from using public transport to complete their journey. Still, the lack of available data is one of the critical discouraging factors in public transportation (Cain, 2007).

The most crucial question underpinning this research is, 'why do we need public transport information?". To answer this question involves considering three stakeholders, namely the user of public transport, the provider of the services, and the authorities that regulate the services. Different stakeholders need different information. It is essential to consider the points of view of each stakeholder in understanding the nature of information required,

2.2.1 The Passengers' Point of View

Public transport information is beneficial in guiding passengers on how to use the services successfully. According to Lyons (2006), there are three influential roles of public transport information:

1. Improve awareness to an individual about all the travel options available to them in planning a journey.
2. Entrust the individual in making a better-informed travel choice.
3. Help the individual in undertaking and completing a journey successfully.

When a person considers a journey, they should compare all the travel options available. In many cases, public transportation will provide direct competition to the private car. Here is when the availability of public transport information can play a significant role in attracting passengers to use a public transport system. Table 2.1 compares the process of travelling by car and by public transport.

Table 2.1: Travelling comparison between mode of transportation

Travel Process	Travelling by Car	Travelling by Public Transport
Journey Length	Door to door accessibility	Start with access into the PT network and exit at nearest station/stop
Available Routes	All road network made available to Public	All road/route networks made available by public transport provider(s)
Transit / Interchange	No need for interchange	The direct journey not always possible, may be needed for interchange
Time for Departure	Flexible departure time, can predict arrival time (traffic permitting)	Depart at a specific time, can expect arrival time,
Travel Time	In control of the speed of travel of up to National Speed Limit (traffic permitting)	Cannot control the speed of travel
Perceived Cost	Fuel	Fares

From Table 2.1, additional travel information is needed by the public transportation system users to complete their planned journey. However, the amount of travel information required is not the same for all passengers.

The regular passenger may not need a lot of travel information. This type of passenger often makes an identical journey from the same starting position to the same destination, using similar services at the same time of day every weekday (Garland, Grubb, & Haynes, 1979). This constant nature of travel has made these passengers aware of the travel information needed for their journey. Additional travel information is only required if there is any alteration to the service that they currently use. The regular passenger will require new information if there is a significant change to the timetable or the route network, or even worse when their routine services are discontinued.

Although regular passengers are the majority of public transport users, the occasional passenger's needs should not be taken lightly. In fact, the occasional passenger’s view concerning the public transport information should be considered more important as these are the type of passengers that require travel information in planning their journey (Suen and Geehan, 1987). Occasional passengers can be further divided into four major categories:

1. Unacquainted passenger: A user with little knowledge about the local public transport system and the surrounding area.
2. Exceptional passenger: Passengers that use public transport only when needed but are familiar with the local geography.
3. Foreign Passenger: Passengers that have an additional barrier in terms of language and local culture.
4. Disabled Passenger: The passenger faces barriers in terms of functional limitations, which are not related to communication difficulties.

The passenger’s view on public transport information gets more complicated as the user’s categorisation and type of journey are dynamic. All passengers will start as an occasional passenger at one point before gradually familiarised themselves with the public transportation system and become a regular passenger. This state of uncertainty also occurs when a regular passenger tries to complete a journey to a different destination (or perhaps at another time). This destination may include a location that they have visited before, but they are not sure about the current transportation services available at the time of use.

A study completed by Balcombe & Vance (1998) found that 83% of their respondents stated that they did not need any travel information in making a regular journey. The percentage of respondents that said they did not need any information reduced to 67% when asked to plan an occasional trip, and only 7% of respondents said they would not require any information when planning a new journey. This study highlights the need for travel information across all passenger types, with only the amount of information needed being different. Passengers demand a public transportation system that is straightforward to use, has clear instructions, and a system that makes them feel confident to use and have control (Lodden, 2002). Providing adequate travel information is an inexpensive way to enhance the passenger confidence in using public transport, which at the same time will help eradicate any negative experiences and improve the passenger trust toward public transport services in general (Derek Halden Consultancy, 2003).

2.2.2 Public Transport Operators

Public transport operators largely depend on passengers in generating their revenue. As such, operators need to encourage more people to use their services by providing an accessible and convenient service, with practical information to let people know about the services. This situation is not made more accessible by the contemporary status-driven social community, where the success level of an individual is measured through the type of car that they possess (Beirão and Sarsfield Cabral, 2007). This circumstance is not helped by the stereotype image that has plagued public transport for a very long time. Public transport is often associated with discomfort and inconvenience and is only used by students, the poor, and elderly users (Stradling *et al.*, 2007).

In terms of attracting passengers, the bus operator competes with other public transport operators and will also face competition from car usage. The bus industry needs to entice people to get out of their cars, thus reversing this public transportation modal imbalance. The bus's image must be improved and be more inviting to new and future users (Ahern, 2002). The main barrier that needs to be addressed is the psychological barrier, where passengers usually think that car travel is much more enjoyable than travelling by bus (Bunting, 2004). Bunting also indicated that the bus industry could do many things to improve its customer relations in order to attract new passengers.

Providing users with accurate information at the right time is one of the simplest ways to do this. User-friendly information products representing an accessible bus service system will let the user know the current bus services on offer, thus helping them make well-informed choices (Lyons, 2006). However, despite the vital role of making good information available, improving the bus information provision alone will not be enough to bring more people to use bus services, as a good information system will not sell a poor service (Balcombe and Vance, 1998).

The improvement of information provision can also enhance public transport marketing schemes. Research shows that transport operators can benefit from the improved information provided through the higher revenues collected and increased bus use. Based on the Transit Cooperative Research Program (1995), two weeks after the British Bus Companies launched improved transport information throughout their service areas in the 1970s, the bus ridership increased by 12%. When Chicago Transit Authority introduced a new travel information system for several of its bus routes, the improvement effect was significant as the weekday ridership for the selected routes had a ridership of 126 more than the bus routes that did not have that new travel information system (Tang and Thakuriah, 2012).

In the United Kingdom, a study done by Enoch and Potter (2002) found that an implementation of route branding by Brighton and Hove Bus and Coach Company led to an annual ridership growth of 8% on its ‘Metro’ routes. Likewise, the rebranding done by First Glasgow through its Overland network resulted in annual ridership growth of 4%, after several years of decline. Cairns et al. (2008) applauded the achievements in Brighton and Hove before highlighting another similar achievement of the information improvement programme in Nottingham. Before implementing the programme, the local bus patronage was declining at 1% per year. Within a year of the new programme implementation, the passenger journeys had increased by 1.8%.

The above statements prove that disseminating good information about public transport is an effective way to let people know about the bus system. If this is done correctly, the impacts will encourage future ridership and continued usage. However, there are still several transport operators that are reluctant to invest in this information provision as the operators believed that a potential passenger can always ask a representative of the bus service, either a driver or the company staff at the station, if they need any detailed information (Ibraeva and Sousa, 2014).

Another reason given by the operators for the lack of information provision is because most of their passengers are regular passengers and not occasional users. Regular passengers demand very little information, which has led to a disdainful stance taken by the bus operators in providing additional information for their bus services (Enoch and Potter, 2002).

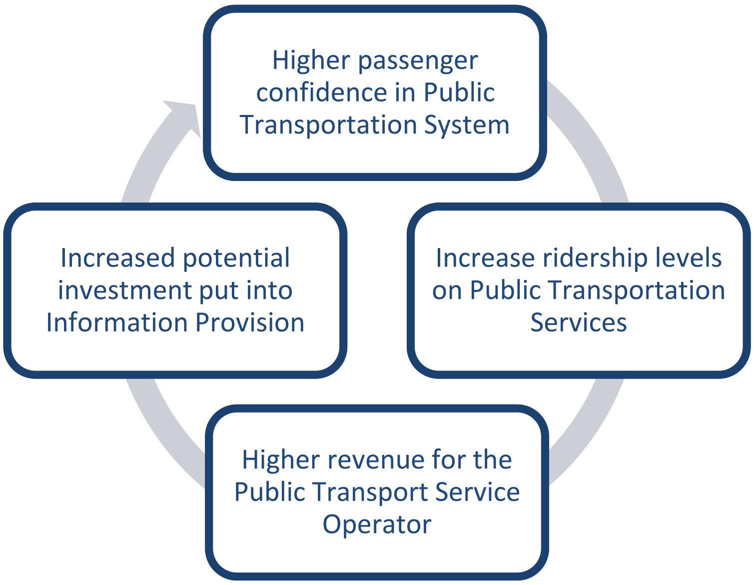

Figure 2.1: Virtual cycle of investing in public transport information (source: Evans, 2010)

Figure 2.1 shows a potential virtuous circle created if the public transport operator continues its investment in enhancing public transport information. Clearly, improved public transport information will benefit the provider of public transport and not only passengers. Providing the information will bring benefits to both parties as the rise in revenues will allow further investment in improving transport information. As proven by several public transport operators (Enoch and Potter, 2002; Cairns *et al.*, 2008; Tang and Thakuriah, 2012), this approach may help in reversing a long-term decline in bus usage turn it into a positive patronage yield in a short period.

2.2.3 Public Authorities

As defined in the first chapter, public authorities need to play a major role in fulfilling all aspects of public transportation's information provision. In this section, the public authorities mentioned are the Government, State and City Council, and other public agencies. The public authorities hold massive amounts of public transport information that can provide the timetables and network map information and network coverage and accessibility information (Fairbairn, 2005). Public authorities must ensure that adequate information is made available to the public transport user. It is vital to distribute the information around the network area and ensure that the user can access the information in various locations. The information should always be made accessible, ranging from the time of journey planning away from the public transport system to the time where the user currently uses the public transportation system.

In Malaysia, generally, buses are the primary mode of public transport in most cities. Only Kuala Lumpur has urban rail transportation (LRT, MRT, and Train) as part of its public transportation system. This situation is likely to stay the same for several years to come. As the local bus networks will continue to be the primary mode of public transportation, the importance of having an efficient and reliable information system cannot be ignored, and it will play a significant role in encouraging people to abandon their cars and ride public transport. However, providing the information can be a challenging task. The challenges can relate to the ever-grown issue of increasing private vehicle usage and better promotion for alternative transportation modes. In Malaysia's case, private vehicle ownership continues to rise throughout the years (Figure 2.2).

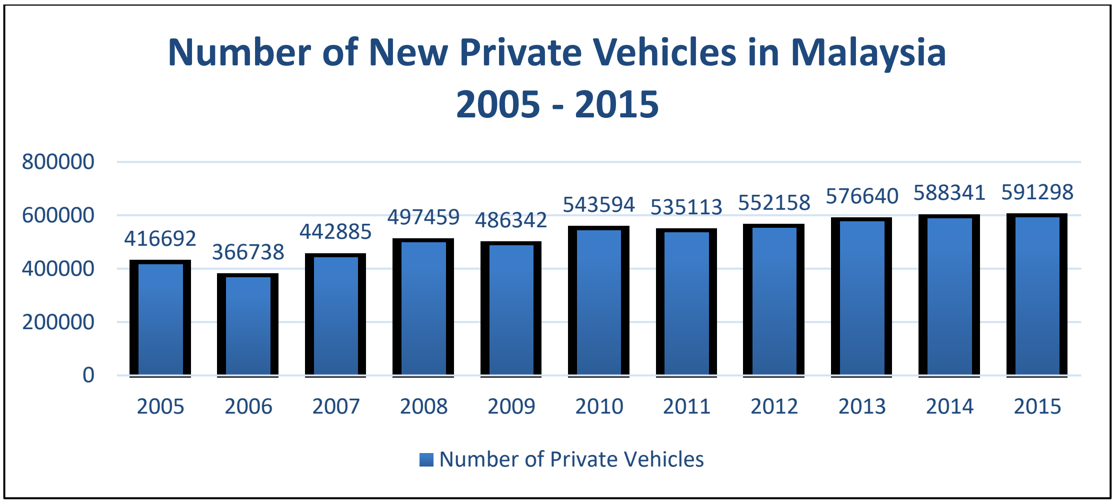

Figure 2.2: The new registration of private motor vehicles in Malaysia from the year 2005 to 2015 (source: Malaysia Automotive Association, 2016)

The numbers consistently exceed 500,000 units every year since the year 2010. Alternatives options must be made reliable and easy to use to stop this increase. Improving public transport systems can be seen as one option in changing the way people travel. Even though bus transportation has many negative perceptions, this mode is still the primary option for public transportation across Malaysia. Users want a public transportation service that is easy to use. One key to making things more comfortable is supplying adequate information for users in their journey planning process, and public authorities should ensure that the required information is supply appropriately. Evidence shows that bus services can be improved significantly by the simple measure of adding the service timetables and displaying route maps at all bus stops (Simpson, 2003). Furthermore, Ben-Akiva & Morikawa (2002) found that enhancement made to bus services can be more efficient, economical and can bring comparable impacts to rail transportation services if the services are conveyed along the same high-frequency transport routes.

2.3 Public Transport Information Categories

Information is essential at every stage of public transportation usage. The stages are linked, thus creating a journey chain. According to Caiafa & Tyler (2002), the usage chain can be divided into three different public transport information categories:

1. Pre-trip information
   Information needed for route planning and connection;
2. In-trip information
   Information needed to assist the user at every decision point along the journey;
3. Supportive / Confirming information
   The information being repeatedly giving. Contain decisive and helpful information to make users feel more confident along their journey.

Information needed at each point is divide into two categories; specific information and orientation information (Dziekan, 2008). When a person plans to start a journey, they will instantly decide where the start point is and where they want to go. Users need adequate information to find the nearest stop, choose the right route(s), board the correct bus and stop at the right destination. Mapmakers often underestimate the amount of information needed by the user to complete a journey. As seen in Table 2.2, Caiafa & Tyler (2002) have listed the types of information that a public transport service provider could provide and cannot provide at every journey stage. The information covers two types of information, specific and orientation information.

Table 2.2: Public transport information applicability

Public Transport Information		
Can provide	Cannot Provide	Limitation
1. The spatial relationship between routes, interchange, and landmarks 2. View of the whole journey 3. The general picture of the transport system currently in services 4. Change of plan flexibility 5. Additional supportive information to be used along the journey 6. Information about any emergency or operational change	1. Effortless availability (User need to obtain the physical map first by themselves before planning a journey) 2. Explicit information (User needs to have necessary map reading skills to understand what the maps' content represent)	1. Users who have difficulties with spatial information 2. Users with learning difficulties 3. Users with vision difficulties 4. Users with language difficulties

After Caiafa & Tyler (2002).

Information in the form of maps certainly provides many benefits to users. Map providers can maximise the benefit by providing the right type of map that suits the user’s current needs. Public transportation maps apply to all journey stages, but additional specific maps for each stage should be made available to cater to the different and more specific public transport usage purposes. Balcombe & Vance (1998) highlighted this need when they stated that different map types serve different purposes at different journey planning and journey-making stages.

2.3.1 Public Transport Information in Malaysia

Previously (before the year 2010) in Malaysia, there is no clear indication of the public bus industry's roles and responsibilities among the public authorities involved (Azmi and Nor Fanim, 2012). Malaysia has a three-tier governance level: the federal government, state government, and local government (local authority). The federal government set out the national transportation policy and regulates the fares while the local authority provides additional assistance towards the system. The public bus transportation system is under the full-management of private sector operators. The private sector manages all the sub-services related to the bus industry, and this includes the provision of bus information systems. It is up to the bus service provider to decide how they will publicise and promote their network services. The local authorities only support in developing the physical infrastructure (bus terminals and bus stops), parking restrictions, bus lane priority, and other traffic management policies in their jurisdiction area. Nevertheless, this assistance often comes with terms and conditions, such as the local authorities will continue to assist only if the public transport service continues as a suitable alternative to the use of private vehicles.

However, bus operators often find it hard to maintain their services due to relying on the farebox revenue model. In this model, the passenger fares are the primary source of income used to cover operating costs and other investment returns. The provider can only continue providing services on the loss-making routes by proving cross-subsidized mechanisms, using the income they get from the more lucrative routes. This situation is not a problem if the number of lucrative routes is more than the number of loss-making routes. Nonetheless, this model presents difficulties when the city is expanding, as the new urbanization areas are less populated, and route expansion will result in more loss-making routes, at least in the short term. Eventually, this circumstance will lead to the bus operator reducing bus routes and reducing the frequency on other routes. The operators take all these measures to reduce coverage of bus network services around an urban area over time. Increasing the fare is not a solution as the government does not want to burden the public transportation system's primary users, which is the low-income population. With the continuing rise in the number of private vehicles and the reduced area covered by the public transport networks, these have indirectly promoted more private car usage and lower public transportation usage. This situation will see the patronage level continue going down and ultimately bring the public transport industry into a classic failure state.

As stated above, assistance from the local authorities comes with terms and conditions. The accumulating depreciation of public transportation systems has made local authorities distance themselves from providing further assistance to support public transport in urban areas. The local authorities always demand the public transportation system to be viably attractive first before they step in, an irrational decisional that will never move public transportation forward. It is noticeable that this classic farebox model is not applicable in Malaysia. The Federal Government acknowledged this problem by establishing the Land Public Transport Commission (SPAD) in 2010. SPAD was tasked with planning, formulating, and organizing the whole public transportation system in Malaysia at the federal level. All the decisions made at the federal level were then cascaded to all lower levels, including the local authorities, thus creating a more cohesive and effective policy in improving the public transportation system.

Through SPAD, the government has acknowledged the importance of information provision as they put particular emphasis on improving the provision situation. In 2010, the government listed improving the quality of information as one of the key points in stimulating people’s demand to use public transport (Malaysian Performance Management & Delivery Unit (PEMANDU), 2011a). They once again reiterate this statement in 2016 by launching the Bus Stop Information Panel (BSIP) project (National Land Public Transport Commission (SPAD), 2016b). The authorities realised that information provided is the key to increasing peoples’ awareness of the existence of the bus operator's services. Potential users often do not know what type of information available and where to get the information. To make it worse, users sometimes misinterpret the limited information they can get and blame the bus provider for confusing them (Balcombe and Vance, 1998). These are among the bus operator's problems. Clearly, the public authorities should take some responsibilities and help the bus provider give the best information possible to the users.

2.4 Cognitive Mapping

Cognitive mapping is the mechanism of encoding, storing, and manipulating the previously used and sensed geographically referenced information (Golledge et al., 2000). There are various ways to convey geographically referenced information, and one of them is the map. Maps can be a simple medium for portraying spatial information, but can often become quite complicated (Monmonier, 1974). Some people may find that map reading is a difficult task (Caiafa and Tyler, 2002). People may misunderstand the map's message during map reading, which involves complex cognitive processes. Different types of maps require a range of human cognitive processes, which means human brains apply different strategies in approaching different map designs (Lobben, 2004). During the travelling process, users depend on their previously gained travel information memories to help them make journey planning decisions. The quality of this stored information is based on the type of transportation mode that they used the most and the level of interaction between users and the local environment along with the previous journey experience (Mondschein, Blumenberg and Taylor, 2010).

Research into understanding the cognitive process involved in map reading has been published by researchers from both psychology and cartography. However, the actual focus of the studies is largely different. Psychological research tends to focus on human cognitive processes' ability, and less attention is given to the forms of map used. Psychological researchers regularly generalize the maps into only one theme and do not differentiate it accordingly (Liben and Downs, 1989). On the other hand, some cartographic researcher may be more focused on the map design factors (based on the maps' theme and map use) and less on assessing the map reader's ability.

Cartographers generally acknowledge the importance of understanding the map reading skills and abilities of the map users in extracting the information from maps (Koláčný, 1969; Clarke, 2003). Ratajski (1977) and Guzmán *et al.* (2008) point out that map reading and interpretation ability can be affected by the map reader's memory. This notion is supported by Morrison (1976) and Ooms *et al.* (2012). They indicate that the map readers' interpretation is not only influenced by the cognitive process happening during the interpretation process but also by the current information cognitively held by the map reader. Robinson (1952), through his work - 'The Look of Maps' - proposed that cartographers acknowledge the decision-making process involved in the mind of map users to improve and understand the map function.

Based on the above paragraphs, it is crucial to recognize the relationship between the cognitive aspect and other map reading-ability processes involved during map usage while travelling. The main task performed during the travelling process is navigation. Navigation is an essential part of everyone's' life. Frequently carrying out navigation tasks will make a person familiar with one geographical area. Over time environment familiarity combined with other strategies and guidance medium (printed maps, verbal and written instructions from the local community) will help the person complete route planning and wayfinding efficiently. All these processes help build a memory of a set of geographic locations visited, thus developing a cognitive map in the person's mind (Lloyd, 2000).

Lobben (2004) identifies two types of cognitive mapping developed by a person according to what they learn from the environment. The two types are:

1. Survey Knowledge
   Survey knowledge gives users a structural overview of the environment. This knowledge is accumulated via graphical representation (in the maps and visual guides) and verbal representation. As the person reads a static map, they will read it from a single perspective. The focus of the reading will be to understand the links between geographical positions with geographical representation. Survey knowledge can also be developed through repeated exposure to the surrounding environment, thus helping a person visualize an area thoroughly (Golledge, 1992). The process of developing a cognitive map with maps or other survey knowledge sources is called survey mapping.

2. Route Knowledge
   The route knowledge is based on the user perspective on what they see from the environment physically, without any help from graphical representation assistance. A person will gain knowledge from various perspectives as they navigate through the actual geographical space. The knowledge obtained through the route knowledge will develop a more effective cognitive model of an area, as the exposure to the real environment helps a person estimate the right relative location and straight line distance among physical objects (Thorndyke and Hayes-Roth, 1982). Establishing a cognitive map using the information gathered from route knowledge is termed 'environmental mapping.'

As a person with route knowledge has an added advantage while performing a navigation or wayfinding task, they are more likely to use and recall the cognitively stored information rather than use additional new information. Nevertheless, this does not mean the added survey knowledge will not be beneficial. When a person with route knowledge starts a route-finding task using a map, their cognitive map is formed through their current route knowledge information. As they start analysing the map, they instantly update their cognitive map with the survey knowledge information. At the end of the task, the person will have developed a more efficient cognitive map based on existing and new knowledge (Lobben, 2004, 2007).

The reliance on mapping information is variable based on the frequency of the journey made by a person (Balcombe and Vance, 1998). The importance of maps in developing an efficient cognitive map will become more critical when a person needs to perform a new journey or a journey into a non-familiar area. At this time, a person may not even have any cognitive map of the location. The level of cognitive map among individuals concerning existing transportation networks is partial and variable, resulting in the difference in abilities to perform wayfinding and other navigational tasks (Allen, 1999; Golledge et al., 2000). They need mapping information that will help them build their survey knowledge and correctly determine which transportation services they should take to complete their journey.

2.5 People's Ability to Use Public Transport Maps

The ability of people to use maps varies significantly. Some people find it is challenging to understand how the maps work due to their limited map reading skills and lack of confidence during map use. Their geographic knowledge is one factor that influences the difference in map reading ability as the level of map reading education in schools varies between countries (Albert, Illyés, Kis, Szigeti, & Várkonyi, 2016). This condition has resulted in different findings in cartographic research, depending on the location of the study.

In Malaysia, only 27% of lower secondary school students managed to perform well on the map reading skills question in the national examination between 2001 and 2003. This situation worsens for upper secondary school students as only 19% of the total student population managed to answer well in another national examination in 2004 (Raman, 2006). The ability to read is different from the ability to read maps. Map reading requires a skill known as spatial ability. Different tasks may require different spatial abilities needed to complete the task. For a person to read the map and perform the navigation successfully, they need to acquire three spatial abilities: map rotation, place recognition, and self-location (Lobben, 2004, 2007).

2.5.1 Map Rotation

The rotation task is among the first problems people face when they encounter map reading for navigation tasks. Shephard and Hurwitz (1984) found that readers need to mentally position the map in the 'up' position before deciding which direction they should take. In cartography, conventionally the north direction is aligned toward the top of the map, but this can vary. However, the direction needed to travel by the map readers will not always go to the direction of 'up' only. The map reader often will need to travel in another direction, thus facing them with the task of map rotation, which can be achieved by physically rotating the map, or rotating it mentally.

Thus, the map reader needs to either physically rotate the map and mentally rotate all other text and symbolization involved in the map; or mentally rotate the map, keeping the actual map together with the all map symbolization in the original orientation. The type of rotation chosen may vary according to the rotation ability they have and the use of strategy. In many cases with paper maps (such as poster displays, or maps at bus stops), mental rotation is the only strategy available, but some map readers, especially more experienced ones, may opt for mental rotation even if physical rotation is possible. These strategies will affect the map reading process, and it is a question of which type of rotation will make map reading more efficient (Aretz and Wickens, 1992). An investigation on the effect of rotation in 'you are here' maps has revealed that the task completion was less accurate and the responses are slower when the maps are not oriented towards the 'forward up' position (Levinew, Marchon, and Hanley, 1984). This finding implies that map geometry's mental rotation is far more complicated than the mental rotation of symbols and text.

It should be noted here that one of the advantages of digital map displays over paper maps is the ability of the software to rotate the map into the 'forward up' position and re-orient text and symbols appropriately, removing this task from the user.

2.5.2 Place Recognition

Place recognition ability is a person's ability to successfully identify an object in the real-world environment and relate it with the object's corresponding symbol on the map. As we know, a person will depend on the map's survey knowledge as they navigate towards the unfamiliar territory. This knowledge will allow them to visualize the overall view of the new area. The map reader needs to mentally transform the two-dimensional map into a three-dimensional form and observe the area's physical characteristics (Crampton, 1992). The processes that allow a person to see a symbol and use their ability to develop a mental representation based on what they see and act upon is called visualization (MacEachren, 1994). Visualization requires the user to effectively predict the future situation based on the information they get from the map. In a real-world navigation process, the map reader needs to decode spatial information that they get from the map and simultaneously compared the information with the real-world environment, hence, creating a mental representation of the anticipated route at the same time. This newly-created mental representation will predict and visualize the route and objects that they may face throughout the journey navigation process.

This visualisation process continues throughout the active map reading and navigating process. A map reader needs to continually visualize the future environment as they steadily compare the map location and real-world situations during the whole map reading process. Ideally, a map should present the real-world's information at the highest accuracy and in the most tangible way to enhance the map reader's place-recognition ability. Providing good mapping information is essential at this entry point, as this will help ease the elements of uncertainty and disorientation during the whole map use process.

2.5.3 Self-Location

According to Lobben (2004), self-location is the ability of a person to relate the map indicators with its real-world representation. To successfully use the map, a map reader will need to recognize their position on the map by understanding the correlation between the maps' landmarks with clues in the real world. Several studies have examined this problem, like the research done by Peruch & Pailhous (1986). In this research, Peruch and Pailhous wanted to know the respondent's point of view after giving them a geometric scene that contained the same size points but in different colours and shapes. Research conducted by Levinew et al. (1984) tried to understand self-location ability in you-are-here maps. In this research, the maps are fixed to a wall and aligned correctly to the environment.

Generally, in a map navigational task, the map reader will observe the real world-landmarks such as an iconic monument, a shopping mall, or a school and use them in positioning their current relative position on the map. As well as using landmarks, a map reader needs to position themselves on a map by using their previous knowledge (using pointers such as the residential type around an area, road style, land use pattern), with individual logical reasoning providing additional help in determining their current location on the map.

It is quite similar to the visualization process, requiring the user to effectively correlate the relationship of information provided in the map and the real-world situation. However, this time the concept works in a reverse manner. Instead of taking the information from the map and comparing it with the real world's observations, self-location requires the map user to take the information from the real world and then relate it with the map's corresponding information. This concept is synonymous with an act of problem-solving. To help increase the map user's self-location ability, a map maker needs to provide an adequate number of landmarks or other contextual information in their maps.

2.6 Map Use and Usability Research Design

The assessment of cartographic products typically encompasses many elements of usability. Robinson's dissertation in 1952 provides the base for scientific research on map use and map usability. The dissertation ignited a more objective approach to map design and symbolization based on assessing the effectiveness of alternatives, a method that complied with the positivist model of physical science (MacEachren, 2004). Based on this foundation, extensive cartographic research and assessment involving the actual map users has occurred. While this research is extensive and not all research into cognitive processes associated with reading maps is relevant here, the usability evaluation approaches are applicable to evaluate any cartographic visualization where users are predicted to complete the task efficiently (precisely) and effectively (correctly).

According to International Organization for Standardization (9241-11, 1998), the term 'usability' can be defined as the extent to which specified users can use a product to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use. Rubin and Chisnell (2008) added that usability acts as the quality indicator of how applicable a product is to its real purpose. The indicator can be determined with several single attributes: effective, efficient, useful, learnable, satisfying, or comprehensible. These are the essential attributes objectively needed by the end-user. This concept can be replicated to the cartographic product's deliverables, where the visualization product should effectively represent all the information shown.

However, usability is often mistakenly defined as functionality, where the ability to conduct a needed function is preferred rather than the efficiency of the ability itself (Dumas and Redish, 1999; Víšek, 2010). The terms should be clearly defined because the efficiency and the effectiveness of a cartographic product are treated as the most decisive attributes of the general usability (Štěrba, Šašinka, and Stachoň, 2014). A "usable map" could be determined by the fastest way to disseminate required information correctly, or in other words, the effectiveness of deliverance of correct information to the end-user. This effectiveness factor could help the cartographer identify any flaw concerning the legibility and readability of cartographic variables. It is essential to see a product's usability as the interaction between the user and the actual usage, not just about the product only (Karat, 1997).

2.6.1 Defining Usability for Assessment

According to Geisen and Bergstrom (2017), usability can be further categorised into five key components which is the product, the specified users of the product, the goals of the users, the context of use, and the metrics of evaluation (effectiveness, efficiency, and satisfaction). The assessment of the product usability can be done in various medium - from paper surveys, apps surveys to web surveys -, and in many ways - from interviewer-administered surveys to self-administered surveys. Self-administered assessments are very liable to produce usability errors, no matter what medium is used for the assessment (Geisen and Bergstrom, 2017a). This situation happens mainly because of the lack of live assistance during the assessment. Apart from that, a respondent could provide false information and not finish the assessment due to confusion, leading to frustration.

Generally, the interviewer-administered assessment is preferable to the self-administered assessment and can eliminate several issues, as mentioned above. An interviewer's presence will provide instant guidance for the respondent should they have any issue with the assessment. Furthermore, the presence of an interviewer will keep them more active and focus on completing the assessment. However, several other aspects need to be managed to keep the quality of the assessment. The other aspects include the overall design of the assessment form’s framework and the time needed to complete the assessment.

Regarding the product's specified users, the researcher must be extra careful when selecting the research respondents. The respondent characteristic may be different depending on the type of usability tested. Priority must be made in selecting the typical user of the product. Nevertheless, consideration must be made to include the non-typical user as this type of user can provide an accurate estimate of usability level within the target population.

The usability survey assessment is about assessing whether the respondent can accomplish the defined objectives, which is the users’ objective and not the product target (Dumas and Redish, 1999; Geisen and Bergstrom, 2017a). A common mistake made by the researcher is to focus more on the product’s target instead of assessing the user's actual capability in using the product. The main objective is to capture the most accurate feedback from the user. Understanding the intended user goals can help the researcher create an assessment that genuinely fits user-centred design principles and ultimately brings an accurate data collection process.

There are three widely accepted metrics of evaluation, which are effectiveness, efficiency, and satisfaction (International Organization For Standardization, 1998; Rubin and Chisnell, 2008; Štěrba, Šašinka and Stachoň, 2014; Geisen and Bergstrom, 2017b). Effectiveness is defined as users' ability to accomplish a specific task; efficiency means the time or the number of steps needed to complete a task, and satisfaction represents by self-rated measurement or qualitative feedback gathered from the user during usability testing. Other metrics can be collected, depending on the research nature and requirements like the added evaluation on engagement and user-friendliness for the web interface system (Quesenbery and Design, 2003).

Improving the efficiency of usability testing can help to lower down the users' burden during the test. Decreasing the burden will decrease the likelihood of the user skipping any question or tasks and crucially reduce the user's choice to exit the test prematurely. The respondent's burden can be reduced by providing a test that has a lower difficulty level. Users should not be forced to overthink how to choose a response and complete tasks. Apart from improving participation and avoiding nonresponse, reducing the respondent burden can contribute to a higher accuracy level. A lengthy test may generate fatigue over time, which directly influences the quality of answers given.

2.6.2 Usability Criteria for Cartographic Products

As mentioned by Štěrba, Šašinka, and Stachoň (2014), the efficiency and effectiveness evaluation factors are deemed the most critical attributes of general usability for any cartographic product. A similar view was taken by Herman and Řezník (2013). The cartographic aspect's effectiveness is meant to measure the general correctness of quantitative information in terms of product usage. For example, it can quantify the effectiveness level of the geospatial information deliverance process from map to the targeted users. This information could help the cartographer to identify any problem with the current selection of visual variables used in the map. In other words, the effectiveness evaluation could help in improving the accuracy and validity of the collected usability test data.

The efficiency can defined as the time needed or the number of steps taken to complete any task, according to the defined map purpose (Çöltekin, Fabrikant and Lacayo, 2010). The researcher can record the time taken by the users in the usability test, and the length of time taken to complete the task will act as the indicator of how efficient the map is. This kind of information can help the map makers to understand the level of complexity. The map's complexity should suit the needs of the target users, and it is the map makers' responsibility to include only the necessary geospatial information in the map. Lower map complexity will reduce the user's cognitive burden while using the map, thus should help to improve their overall efficiency.

Satisfaction is the other aspect of usability that is crucial in cartography. Satisfaction conveys a subjective view of the tested deliverable. For cartographic visualizations, all the map components, from the selection of visual variables to the overall placement of the variables, have a direct impact on the user's satisfaction and their perspective. The satisfaction aspect is exceptionally subjective, which could indirectly impact the general usability of any cartographic product. These criteria can be measured through physiological and cognitive aspects during the map reading process, as discussed in section 2.4 above. Albert and Tullis (2013) and Fabrikant *et al.* (2013) agreed with the influential impact of the user's experience on the satisfaction level. Albert and Tullis (2013) state that the experience will enhance the capability to complete a task because of the past involvement with any respective visualization, which makes it essential for further research to consider this factor during the evaluation stage.

It is important to note that a users' stated satisfaction or preference may not always reflect their effectiveness and/or efficiency in using a product. User preference can also change from pre-use to post-use (Plesa and Cartwright, 2007).

2.6.3 Location for Usability Testing

Apart from planning the map usability test and the appropriate journey-planning tasks, it is also vital to determine the appropriate location to conduct the map test (Board, 1978). Various methodologies and a wide range of demographics samples and tests have been used in previous studies related to public transportation information usability and user tests. This test is initially planned to be conducted in both the real-world situation and in laboratory conditions

Laboratory conditions are often used in map user/usability studies as this situation gives the researcher control of the external environment factors that can affect the research findings. This situation allows the effects of different task situations to be monitored and recorded scientifically. However, the uncontrollable external factors cannot be measured using the laboratory situation. In completing a journey planning task when using a map, some external factors, such as commuter's distraction, lighting conditions, and weather, can affect the user decision-making process in the real world.

The laboratory-based map user tests draw inevitable criticism due to the different environment to the real map use situation. Laboratory testing often lacks the essential element of realism, which means the result produced is not compatible with the real commuter's behaviour outside. The absence of real-world conditions and features in a close and control space area is identified as the main disadvantage of laboratory testing. The research's primary contextual information cannot be measured, and understanding of the actual user behaviour and activities may not be sufficient (Robson, 2002; Van Elzakker, Delikostidis, and van Oosterom, 2008). However, it is premature to dismiss the beneficial potential brought by laboratory testing. Some objections in terms of laboratory 'realism' are not indisputable. Some cartographic attributes require meticulous testing in laboratory conditions so that external factors do not influence results (Falk and Heckman, 2009).

On the other hand, real-world testing provides the cartographic researcher with the real conditions of the map use situation, depending on the map's real purpose. The researcher should consider experimenting in this way if there is a suitable and ethical way to conduct the study in that type of environment (Knottnerus and Tugwell, 2010). For example, testing a bus map in the form of a stop-specific bus map will perfectly fit the purpose of this real-world testing. The main reason is that the stop-specific bus map is being made specifically for one bus stop, and the map is not useful if used at other places other than the intended location. The map test requires the participant to replicate their surroundings and orient themselves at the particular specific bus stop for the map, which will be difficult if the test is only done in a laboratory setting (Evans, 2010).

Cartographic user testing is often different from psychological user testing, where the primary focus will be on the laboratory condition as the prime location to conduct a test (Falk and Heckman, 2009). As stated by Perkins (2008a), there is no single best approach. The map test should prioritize how and why maps are used. Here, the map's primary purpose should be considered, which is to assist users in planning their bus journey. The whole-network bus map makes it possible for the journey planning process to be performed even before the user leaves their home or office. This process supports the approach of map user testing in a closed area, like the laboratory condition. Nevertheless, the map will also be used as part of the public bus infrastructure (bus terminal, bus stop), which indicates the need for real-world testing. There are no issues regarding the user orientation while using the maps, whether the test is being done in the laboratory or in real-world situations, as the user will face the same difficulties in positioning themselves on the map in both situations.

2.7 Usability Evaluation Methods in Cartography

As mentioned above, a usability evaluation or usability test will let us know whether a respondent can complete the task without any significant problem. To get the most accurate answer from the test, it is essential to choose the best evaluation method based on the intended outcome of the research. Understanding the type of data collected will help eliminate the issue of collecting too much or too little data.

They are two types of data: qualitative and quantitative. The quantitative data gathered during a usability assessment is not intended to be generalized to represent the preference of the whole population; it is solely intended to find and recognize the potential usability issues (Geisen and Bergstrom, 2017b). According to Kumar (1999), a study is considered as quantitative when the researcher wants to quantify the diversity of a situation or phenomenon, when the information is primarily collected using quantitative variables, or if the analysis is done objectively to determine the degree of variation. An example of this type of quantitative map usability research can be seen from Brodersen, Andersen, and Weber (2002), where they assess how long it takes for a respondent to perform a specific map use task and how many respondents give the correct answer. Other general empirical map use research examples can be seen from Guzmán Luján, Pablos and Pablos (2008) where the perceptual-cognitive skills associated with sports performance in orienteering were investigated.

As well as the above approaches, there is a need for a more extensive analysis to understand the respondent's overall cognitive strategies. Here, qualitative analysis is essential to fulfil this purpose and deliver the expected interpretations (Štěrba, Šašinka, and Stachoň, 2014). Every conventional qualitative measure, such as interviews and questionnaires, could be very effective in delivering the target of usability research. The result of a qualitative assessment can clarify the inconsistencies found in the final results of thorough testing or within a single task/objective. For example, the cross-reference analysis between the percentage of users who complete an assessment with the researcher's observation or any feedback made by users during and after the test would clarify which user has a problem with the task. Subsequently, the findings will give a vision on how to solve the issue.

2.7.1 The Questionnaire, Interview, and Observations

There are three main data collection methods for both types of data: the questionnaire, interview, and observations (Kumar, 2011). The questionnaire is a series of written questions that a researcher prepares and users answer (Suchan and Brewer, 2000). There are two types of question, the closed question and the open question. The closed question is the most structured kind of question where the respondent can only respond based on the selection of the researcher's choice of answers. On the other hand, the open questions enable the respondent to respond in their own words. They can put their viewpoint in answering questions. The closed question has a slight advantage over the open question in terms of data comparability. The closed question is in a structured format, and this assures the data comparability as the researcher will ask the same predetermined set of questions in a similar structure and order and there is a limited number of outcomes. Open questions are likely to require more effort to interpret and to compile general outcomes from multiple respondents.

With this advantage, the closed question questionnaire can be completed by the respondent without the researcher or investigator to be present during the test session (Kumar, 2011). This unattended answering session – where questionnaires are sent by mail, list on the web, or publish in mobile apps – can help save travel time and reduce costs. Nevertheless, this method may contribute to the low response rates and inferior quality of the given answers.

Many cartographic researchers have utilized the questionnaire in their research. Davies and Medyckyj-Scott (1994) used a closed question questionnaire in their research on effective user interfaces for GIS. Structured statements such as “I find the GIS very cumbersome to use” and “I like to use the GIS frequently” were given to the respondent, and the respondent selected Likert-scale options from “strongly disagree” to “strongly agree.” As for open question type, Slocum (1995) used open questions when investigating the significance of technology transition on the practice of cartography at private organizations and government agencies. An open question such as “What advantages and disadvantages have you seen as a result of converting to an automated operation?” was asked in the study.

Interviews are similar to questionnaires but appear more social communication (Suchan and Brewer, 2000). During an interview session, the respondent shares their experience based on a situation created by the researcher. The respondent is selected based on the researcher's specific conditions, and the questions given are mostly in open-ended format because the researcher is more attentive to the respondent’s subjective feedback and comments. However, the researcher needs to follow an interview guide to keep the scope, direction, and data comparability coverage between all interviews done during the research (Merton, 2008). An interview with a respondent can be divided into two different types, which are structured and unstructured. An unstructured or in-depth interview can be done in individually or simultaneously with a group of people.

The interview method’s advantage is that much information can be collected, encompassing a more comprehensive depth of knowledge than initially known during the start of the project. However, it is quite challenging to correlate answers obtain from every respondent with the questions. Bias may happen on the interviewer's side as the interviewer gains more experience during the interview. On the other hand, the structured interview offers assured data comparability as the interviewer will ask a similar predetermined set of questions in a similar structure and order.

An example of cartographic research that utilizes the interview method was carried out by Brewer in 1989. In this research, Brewer (1989) carried out telephone interviews with chosen cartographers to investigate colour charts' efficiency in map production. This session highlights the main component of the open-ended interview where the researcher provides the primary material (colour charts), the respondents selected were prominent in producing colour maps, and there was a strict guideline that covered the entire interview session. This interview method was also adapted by Slocum et al., (2004) as the researchers interviewed to solicit user’s reaction and responses to software used to explore spatiotemporal data associated with point locations.

The are several problems associated with the questionnaire and interview method. One of the problems is the data gathered using these two techniques can be less accurate due to the distraction of the respondent's cognitive process. The distraction may be caused by the irregularities in the questionnaire's structure or a flaw during interview session. Another problem is that the respondent may not be willing to rationalize and clarify their problem-solving behaviour (Van Someren, Barnard and Sandberg, 1994). This is where the observation method has advantages as the above problem may not occur if the problem-solving behaviour is observed during the data collection process. According to Kumar (1999), "Observation is a purposeful, systematic and selective way of watching and listening to an interaction or phenomenon as it takes place." In the most simple observation, the researcher may watch the respondents during the usability test and make notes on every respondent's action.

Nevertheless, this type of observation may not deliver verifiable results. It is impractical for the respondent to describe their feeling meticulously when their focus is on something else (looking at the test). This problem shows the need to collect implicit data. These implicit data evaluate the behaviour and physiology aspect that is impossible for the respondent to be aware of. It is appropriate to use proper electronic recording equipment to record the observation, and eye-tracking equipment is one of the effective way to achieve the purpose Albert and Tedesco (2010).

2.7.2 Eye-Tracking Method

Eye-tracking helps us collect data about what the respondent looks at, how frequent the respondent looks at a specific view, the sequence of elements they look at, and how long they stare at elements. The type of data collected by an eye-tracking unit is fixation count, fixation duration, and saccades (Schall and Bergstrom, 2014). Fixation is the position of the eye when the eye is relatively static. The fixation count data can be used to know where the respondent looked once the survey is complete, determine which space gets the most attention, and determine the sequence of elements that the respondent glance. A repeating fixation may indicate the respondent's difficulty in a particular area. The fixation duration lets the researcher to know the respondent's length of time upon looking at a particular area. A short duration may only be milliseconds. The longer duration spent on an area can be linked with difficulty in processing the information or indicating interest or affection on the particular spot (Ooms *et al.*, 2012).

Saccades help to generate a visual hierarchy by measuring the respondent's eye movements during fixation. The data can reveal the viewing order made by the respondent on every visual component shown. Besides the above benefits, eye-tracking could offer many other beneficial findings for a usability study. It will provide the best finding for the assessment meant to measure both gaze and attention (Jarrett and Bergstrom, 2014). Gaze can be defined as the place where the respondent looks, and attention means the current situation that the respondent is concentrating on. Eye-tracking performs best when both gaze and attention are at the same place.

The above study has shown how the researcher uses eye-tracking to understand question stems, reaction preferences, and visuals in a self-administered survey (Jarrett and Bergstrom, 2014). In research by Galesic *et al.* (2008), they discovered that the respondent spent a long time viewing the option placed above a list of responses. Another discovery from the research is the respondent who takes a longer time to read the whole response list also read every element in the form, including the instruction parts and the end credit. Eye-tracking was proven beneficial for all the purposes stated above and provides extra information that cannot be supplied by any self-report or observational data. It does require the availability of the necessary hardware and software, but with the significant reduction in cost of such equipment in recent years and its increased portability it is likely to become much more widely used in cartographic usability studies.

2.7.3 Think-Aloud Method

Verbal probing or think-aloud protocols are two methods for collecting respondent explanations and reactions in a usability test. In think-aloud, the respondent verbally expresses their thinking and actions during the test. For verbal probing, the researcher asks the respondent several questions about their experience during the test. The expression reveals what the respondent thinks during the test and the reason for any difficulty they may face during task completion. A usability study can integrate both methods in a single study. However, this can be challenging, and usually, only one of these methods is selected, with think-aloud being the primary method adopted by usability researchers to assess web applications or other products (Nielsen, 1994; Dumas and Redish, 1999; Barnum, 2011).

Ericsson and Simon (1980, 1984) are among the earlier researchers who develop think-aloud as interviewing methods to understand the process involved in working memory. Loftus (1984) then utilized the think-aloud method in survey-related assessment, in which the researcher tried to understand how the respondent answers the research question given. This method has been widely used and favoured for pilot test surveys that utilize the cognitive interviewing medium (Willis, 2004). During a cognitive interview, a moderator will interrogate the respondent with the survey questions. The respondent then answers the question with their own opinions or thought that arise while composing the answer. Developing and creating the survey question is essential for the think-aloud approach as a cryptic question can lead to inconsistent feedback (Geisen and Bergstrom, 2017a). It is vital to create a survey question that leads the respondent to give the research's intended information.

The think-aloud approach can be an effective technique to help understand the whole cognitive process during the interviewing session, including how the respondent interprets the question given, their reaction, and the reason behind their reaction towards the task given (Delikostidis, 2011). This method helps the researcher understand the most accessible and most challenging part of the task if any confusion arises related to the subject matter. The think-aloud method also assists in getting unbiased reactions as the researcher or the moderator only has a minor involvement throughout the interview session (Geisen and Bergstrom, 2017a). The moderator's role is mainly active during the early part of the session, where the moderator gives a set of instructions and questions. After that, the moderator only speaks to remind the respondent to think aloud until the session ends. This condition would give a relatively interfering-free session for the respondent, without any sudden interruption by the moderator.

Despite the potential offered by the think-aloud method, it has not been capitalized in cartographic research. Nevertheless, there are several investigations that applied this method in map use and map usability research. For example, Crampton (1992) utilized the think-aloud method in his research to find the disparity between experienced and novice wayfinders. The participants involved in the research viewed a map to determine how they can move between two given locations. The verbal statement given by the participants during the decision-making process were recorded. The researcher then created behavioural graphs based on the recorded statement, which help the researcher comprehend the underlying process taken by the participant in solving the wayfinding problem and ultimately figure out the most popular and most effective procedure used by a participant in wayfinding.

The think-aloud method has also been used to analyse the usability of electronic maps, as in research by Lavie, Oron-Gilad, and Meyer (2011), where the authors tried to assess the participant’s ability to solve navigation tasks in an unfamiliar environment. In this research, the participants used an electronic map display to execute the navigational tasks. Apart from helping the researcher know the participant’s actual ability to complete the navigational task, the use of the think-aloud method also helped to measure the usability perception of the given map display. The think-aloud approach has also used to investigate pedestrian maps' usability issues in smartphone devices, as demonstrated by Delikostidis (2011). In the research, the author tested a prototype mapping system on twenty-four participants that were selected based on their previous experience at the testing locations. Video and audio were simultaneously recorded throughout the navigation and map reading tasks session. This technique proved useful in finding out any difficulties faced by the participants

However, several limitations apply to this method as the primary usability approach. The think-aloud method may not benefit automatic tasks or situations where the respondent's reactions are instantly processed as respondents cannot easily express their real reaction (Davis and Bistodeau, 1993; Sugirin, 1999). Furthermore, Rubin & Chisnell (2008) highlighted that the think-aloud method might be disadvantageous when the respondents performed tasks that are customarily done impulsively. A reactivity effect was initiated during the think-aloud act, where the respondent becomes more cautious, thus interfered with their actual capability to finish the task. Furthermore, the respondents may also not fully verbalize everything they do as the verbalization process does not have the same pace as the cognitive process (Van Elzakker, 2004). These limitations may be why the think-aloud method has not been widely used in map use research.

2.8 Conclusion

This chapter has revealed several findings. Clearly, there is a need to create usable public transport information, not just for the user but also for all the stakeholders involved in this transportation industry. Good, well-designed public transport information will attract passengers to use the transportation system and help them make an informed decision before, during, and after their journey. Attracting many new passengers will help public transport operators make more profits rather than continued losses. Simultaneously, public authorities will reap benefits from this as a rise in public transport use can alleviate a broader socio-economic issue related to urban traffic management and heavy traffic congestion.

General impressions of public transportation are essential, and an excellent general impression should positively impact the whole public transportation system. Users want a service that looks clear, easy to use and have confidence to use it right from their first point of contact. Presenting a transportation network in the most understandable and useful way at the right time should make this possible. The improvements made in public transportation should not just focus on the physical infrastructure. Wijaya (2009) and Muhtadi, Mochtar, and Widyastuti (2017) agreed that a modern-look bus stop, a new bus, or an attractive high-resolution digital information resolution would attract the passenger to use the system. However, it is also essential to acknowledge that a swift journey planning process plays much weight in encouraging the passenger to use the public transportation system and promoting the usage to the other people in their life circle.

Concerning the Malaysian situation, it is apparent that there is a critical need to improve public transport maps and information. Particular emphasis needs to be applied in the sector to gain more public confidence in using public transport. Users are presented with inadequate information about the whole-networks, resulting in the inability to plan their travel optimally. There is a clear gap showing the need for a new bus map design to show all the bus network routes and provide guidance to the users during the journey planning stages. This research will take the findings of this review and attempt to answer this need for such map design.

CHAPTER 3

Classifying the Diversity of Bus Map Design

3.1 Introduction

With the rapid development of cities worldwide and the advancement of bus transportation systems, properly formulating and presenting adequate information in just a single map may not be easy. It is essential to understand the current cartographic representation variations used in bus maps. Public transport maps are one of the most significant cartographic items globally (Ovenden, 2005), but the volume of literature on the cartographic design aspects of public transportation systems does not reflect this. By understanding the variation, the map maker will have a better perspective on delivering the right information in the most appropriate style.

This chapter begins with a discussion of current public transport map design guidelines and map design styles. The essential map elements and the important visual variables used in public transport are also discussed. The chapter continues with a detailed explanation on the bus map review process adopted and a review of 55 published bus map products. The process of the review was aided by a technique called content analysis. The analysis is presented based on the pre-determined code and classification, accompanied by a series of graphical examples to illustrate the results. The resulting classification and analysis from the bus map review is then used to guide the process of designing two whole-network bus map prototypes.

3.2 The Design Guidelines for Public Transport Maps

First, it is essential to understand the various aspects and characteristics involved in current public transport mapping. Knowledge about this type of information is beneficial, as the cartographers will employ a variety of cartographic techniques either consciously or not, including simplification, abstraction, and symbolization, to enhance the clarity of the map and synthesize the most critical information (Belbin, 1996). Characteristics in terms of the transport system mode, map style, design elements, map users, and graphic constraints must be considered when cartographers visualize any public transport situation in a map (Kennedy, 1999; Morrison, 1996b). Different modes of transportation need different styles of map design. Mapmakers need to understand the essential characteristics of public transportation before designing the map. These include the number of transportation modes and services in the area, the dominance of each mode, route variance, and the number of stations or stops.

In addressing these factors, this research has accessed several published guidelines on the design of public transport information:

1. Design Elements of Effective Transit Information Materials, National Centre for Transit Research at the Centre for Urban Transportation Research, University of South Florida (Cain *et al.*, 2008b);
2. Report 45, Passenger Information Systems: A Guidebook for Transit Systems by Transit Cooperative Research Program, TCRP (Higgins *et al.*, 1999);
3. The Design of Public Transport Maps - PhD. Dissertation, Polectinico di Milano (Allard, 2009).
4. Printed Public Transport Information – A Code of Good Practice by ATCO, United Kingdom (Association of Transport Co-ordinating Officers, 2003).

The first transit map design guidelines referred to in this study are published by the National Centre for Transit Research at the Centre for Urban Transportation Research, University of South Florida. The guidelines are produced explicitly for printed transit maps; a medium deemed portable, accurate, and independent (Cain et al., 2008). The framework of this guideline rests on the compilation of good design recommendations from exceptional published bus maps. The guidelines are made from the analysis of three primary resources: previously published design guidelines; research that focuses on enhancing user understanding through design identification; and current best practice in portraying transit information made by design consultants and transit agencies.

This guideline is presented in three segments, starting with general publication guidelines, followed by a specific map design guide based on the type of map format used and finishes with guidance on explaining the instruction part on the map. The first segment explains the general design elements that can be applied across all map formats. The design elements include the type of font, type size and case, level of contrast and colour selection, and the printed material to be used. This guidebook recognizes three map formats typically used in portraying bus information. The three formats are the system map (whole-network), the route map (single route), and timetable only (bus schedule). Each map format has its guide section and further detailed guidelines regarding map styles, graphic variables and symbolization, text selection, visual hierarchical level, and figure-ground organization. The last section gives an insight into the instruction part. Informative instructions about how to use the information can help users to use the maps efficiently. Effective instructions should consist of the right combination of text and graphics and be placed on the same page as the primary map (Cain et al., 2008).

The Transit Cooperative Research Program (TCRP), a transit industry improvement program under the Transportation Research Board, National Research Council of United States of America, carried out a project that attempted to provide guidelines to standardize transit map design. TCRP published a report, namely ‘Report 45, Passenger Information Services: A Guidebook for Transit Systems’ in 1999, to guide how to design user information assistance (Higgins et al., 1999). In this report, bus maps are recognized as passenger information aids, which can provide supportive information that can be used before or during a trip. This guideline was purposely made to improve printed transit maps and not be used to design maps for other modern media (paperless). The report comprises three comprehensive sections. The first section explains the type of information needed by the passenger. The second section outlines the recommendations on the type of information aid to be used, and the third section specifies the design elements and format details that are recommended to be placed in any user information aid. This report's source is transit information materials from Europe, Canada, and the United States.

In the second section, detailed recommendations are given on choosing the information aids that bring the best benefit to the user. The recommendations encompass the detail that needs to be represented on the map (transit and topographical elements), legend placement, and the map's size to be used. The third section continues by presenting guidelines on several other important map design aspects. These include the typeface to be used (including type size and visual angle), the use of contrast to differentiate between multiple colours representing each service or route network, and suggestions on landmark placement.

Research by Allard (2009) is worthy of mention as another good attempt at developing transit map design guidelines. In the research, Allard makes recommendations based on his professional experience and design principles from other good practice sources in map design. Allard highlights the importance of carefully selecting the graphic language and type of map to be used. A transit map is a part of a complex information system, and as such, the graphic language used must be systematized with other parts of the system (Allard, 2009). The usage of graphic language that corresponds to the transport agency identity should bring more validity to the map, although careful selection needs to be made if the identity could interfere with cartographic design principles.

Regarding the type of map to be used, Allard recognized there are three common types of maps used to present transport information, which are Schematic Maps, Overlay Maps (Geographical), and Hybrid Maps. He went on to acknowledge several vital findings from Morrison's (1996) research. He agreed with an essential finding from the Morrison research that schematic maps are not suitable for portraying bus information. Similar to the other two guidelines mentioned above, the specific recommendation was to choose graphical variables, choose the colour and adjust contrast, typography, lettering designation, legend symbolization, landmark placement, and map size and format.

The fourth map design guidelines referred to in this study are published by the Association of Transport Coordinating Officers or ATCO. ATCO is an association that gathered authority officers who are responsible for transportation passenger in the United Kingdom. Their main objective is to create and advocate good practice and promote transport action targeted at achieving better passenger services - through information exchange and different perspectives discussion within their association. As such, a guideline was developed to assist the production of printed public transport information for the transport passengers, especially during the map creation and map design process. This document is another guideline that was purposely made to improve printed information materials. Among the essential design criteria highlighted by this guideline is the type of paper and paper size to be used, colour selection and the importance of having a good visualization of figure-ground level in the printed maps.

3.3 Diverse Styles of Bus Map Design

The primary consideration when creating a map is to identify its general style. A map style is created when several map samples share one recognizable characteristic and other similar visual correlation (Bartz Petchenik, 1974). Each map has a distinctive design form and cartographic details. Morrison (1996) presented a useful classification of bus map design styles in his study of the design of public transport maps in Western Europe.

Morrison indicated this distinction in aspects of design between the maps is the result of various factors such as cultural differences, local user’s knowledge, and the number of different transportation modes and services provided around the service area. Morrison found that public transportation maps in France tend to use one distinctive style. The situation was different from what he found in Spain and Germany, where more design variation can be seen in their public transportation maps. He later expanded the research to a larger area, encompassing Western Europe's broader area in 1996 and 2000 (Morrison, 1996a, 2000). He managed to classify the map style into four main categories based on an extensive review of public transport maps available. The four main categories are as below:

a) French Style

This style uses one line for each service/route of a transportation mode. Each line is represented in a different colour, and the individual service numbers appear at termini only. This style can be found in France and other French-speaking areas (most Belgium and Switzerland).

b) Classic Style

This style uses only one-line style for all the transportation routes. The individual services numbers are marked alongside the respective line. This type of style can be found in Britain, Italy, and several Portuguese towns. Traditionally, this style was a trademark in Britain, as the bus roads were portrayed in a wide red line with the service number marked in white along that line.

c) Scandinavian Style

As the name implies, this style can be found mainly in several main cities in the Scandinavian region and some cities in Austria, Spain, and Germany. This style is similar to the classic style, but each subdivision of a transportation network is represented in a distinctive line style. It is used to differentiate multiple transportation modes around the area (underground, tram, or bus). In this style, multiple lines in different colours will be marked on the street used as a transportation route. If there is only one mode of transportation available, the difference in colours will represent that mode's different service patterns.

d) Dutch Style

Dutch style is another style that is similar to the Classic style. In this style, distinctive symbols are used to represent each transportation mode. For example, a single line style is used to show buses and another single line with alternating white and black colour to show trams. Most of the cities in the Netherland use this style on their public transport maps.

Morrison does not give any strict rules on which style a public transport map should use, but he provides a comprehensive guideline on choosing the most suitable style. One of his suggestions is to choose French style as the priority style as this style makes it easier for a reader to clearly observe the bus route and the bus terminal on the map. The French style uses a line for each service with a different colour used to represent each service. The service numbers are shown at the route termini. However, the French style has a flaw in identifying the bus service number as the numbers are not placed alongside a specific route, only at the terminus. This flaw is not present in Classic style as a reader can clearly see the bus services that use a particular route. An obvious compromise would be to add route numbers to the French style at strategic locations as well as those at terminals. Morrison stressed the importance of a map's legibility, mainly when the map contains more than two transportation modes. The graphic variables chosen to represent the different transportation modes, and their service characteristic should be legible and clear so that a person will not get confused. For example, misunderstanding a bus line with an underground railway line may result in a person waiting at a bus stop for a service that never existed.

Other than Morrison’s landmark work, there few other publications that involve classification and characterization of public transport maps. The emergence of multiple guidelines on creating a useful map has highlighted the general practice currently being applied. Cerovic (2016) indicated that transit maps could be categorized into two main categories, which are Geographical Approach maps and Schematic maps. Based on his findings, the selection of map category to be used is purely independent as the choice of category did not relate to any particular urban pattern or population size. Cain et al. (2008) agreed with these two map style categories, as mentioned in their map guidebook for transit map providers, but besides recognizing the geographic and schematics map style, they go further in proposing a two-map style of categories under the schematic map styles. Schematic maps can be further divided into the semi-schematic and the full schematic.

Although it has attracted significant attention in recent years, the schematic form is not the only answer for all public transport map representation. Avelar (2008) highlights the main differences in map design restrictions and rail transportation requirements compared to bus network mapping. Table 3.1 summarized these differences.

The map context and map user characteristics bring further essential aspects to the mapmaking process, which reflect the local and cultural values of the map area. The mapmaker needs to understand the familiar landmarks, points of interest, and references in the map coverage area that need to be put into the map. Local and regional contextual interests must be taken into consideration to attract more users to use the maps. Different locations may require different types and number of landmarks placed onto the maps. Furthermore, there may be cultural differences in understanding mapping concepts, the colour selection, and other related map design aspects.

Table 3.1: Difference in requirements of mapping for different modes of transport

Cartographic Design Elements	Transport Mode			
	Bus	**Tram**	**Underground**	**Train**
Transport Lines	Simplified Lines	Schematic or Simplified Lines	Schematic Lines	Schematic or Simplified Lines
Background Information	Generalised features. Show streets, hydrography, parks, and reference places.	Some generalised features Show simplified hydrographic features.	Plain background. Show simplified hydrographic features and overground railway networks.	Plain Background. Show simplified hydrographic features.
Routes Representation	One route per service or any other same services together	One route per service or any other same services together	One route per service or any other same services together	One route per service or any other same services together
Stops	Rarely named	Often named	Named	Named
Labels	Main streets, landmarks, hydrography features, services alongside lines.	Services showed alongside lines or at line termini.	Services showed alongside lines or at line termini	Services showed alongside lines or at line termini

(Modified from Avelar, 2008)

3.4 Current Bus Mapping Design

There are three map design genres used in current bus map representation. These are the Geographical Approach form, the Full-schematic form, and the Semi-schematic form. Different types of map forms use different rules in the creation of a bus map. These rules impact on simplifying the map's information and the level of map comprehension itself (Grison *et al.*, 2017). Maps in semi-schematic or schematic styles tend to have topographical distortions (Roberts *et al.*, 2013). These distortions simplify the information, which clarifies the route information somehow, but may make it difficult for people to understand the overall geography. Guo (2011) mentioned that the points (nodes) between transport modes or lines are frequently not well represented. Thus, the information will be miscomprehended by the users. The figures below (Figure 3.1 to Figure 3.3) show examples of Geographical Approach, the Full-schematic, and the Semi-schematic form use in portraying bus service systems.

Figure 3.1: Full-network Geographical Approach bus map of Amsterdam

(Source: Gemeentelijk Vervoerbedrijf (GVB), 2012)

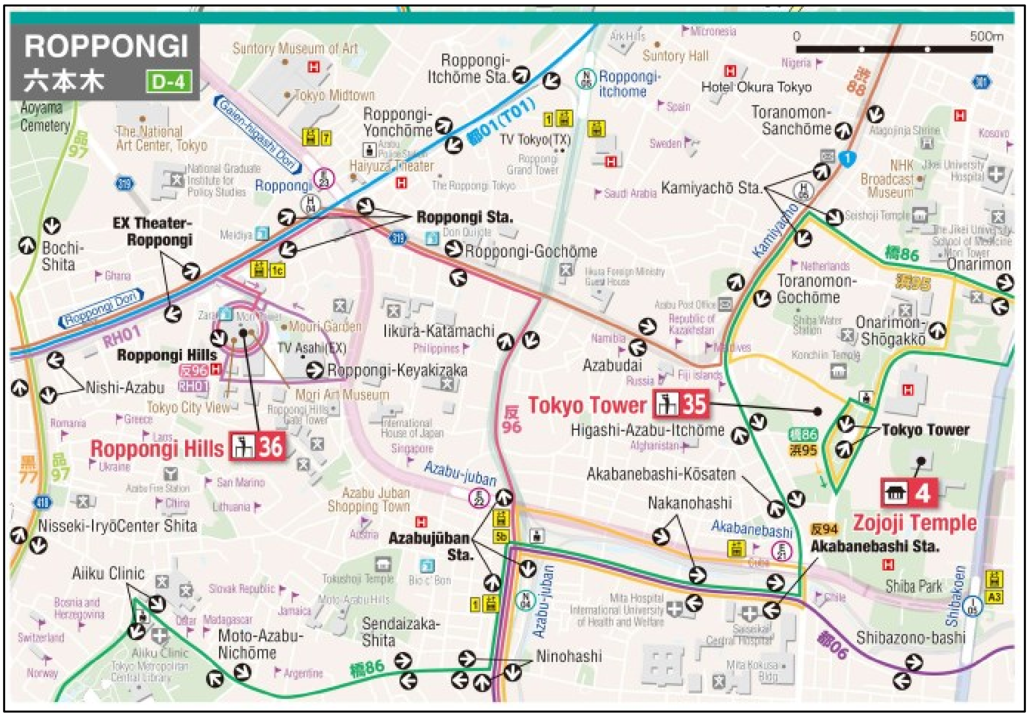

Figure 3.2: Full-network semi-schematic bus map of Roppongi, Tokyo

(Source: Toei Transportation, 2018)

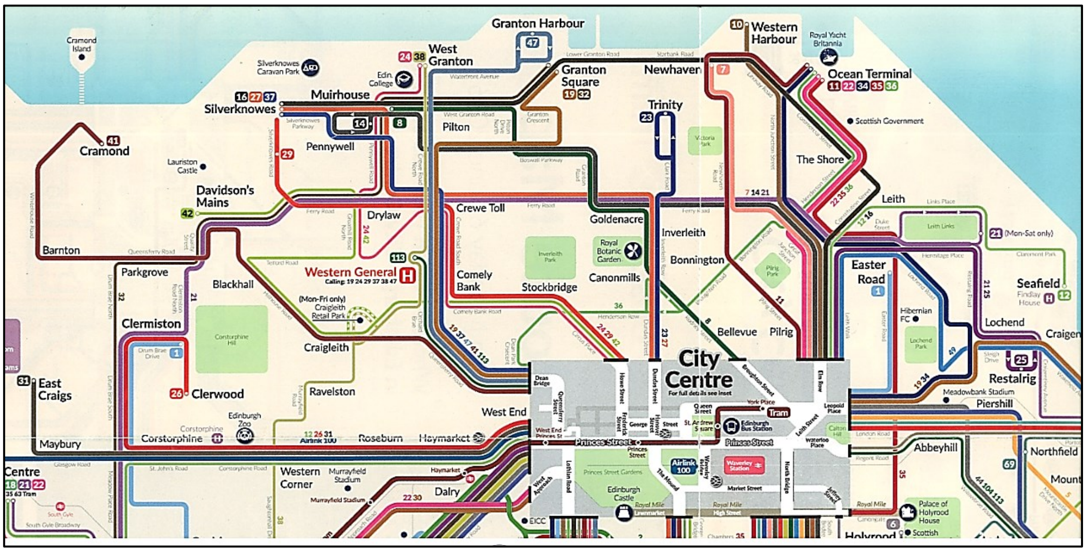

Figure 3.3: Full-network schematic bus map of Edinburgh, United Kingdom

(Source: Transport for Edinburgh, 2016)

Further discussion and more map examples of these three styles follow below.

3.4.1 Geographical Approach Map styles

Geographical Approach map styles maintain the correct scale and distances of an area on the map. Although the schematic is an approach that has gained popularity in bus map design, the Geographical Approach is still a valid approach to portray bus routes. The Geographical map approach can be identified as a map that uses a topographic map or street map as the basis and background with a fixed, uniform scale and minimal distortion of space. The bus routes are drawn to follow the original shape of natural and human-made features on the base map without any significant distortion and change of line shape. Figure 3.4 show an example of this map style representation. As we can see from the figure, this type of map tends to show all the essential transport information at the highest level of positional accuracy.

The amount of information presented in this type of map can be comprehensive, making it far more difficult for the user to read (Denmark, 2000). Morrison (1996) indicates that bus maps should be presented in the Geographical Approach style as this style provides a vast amount of base information that will help improve the self-location ability of a map reader. Another example of this bus map type can be seen from Oxford's Bus Map (Figure 3.5). The bus routes are drawn to follow the original shape of natural and human-made features on the base map without any significant distortion and change of line shape. This bus map also includes the precise location of all bus stops.

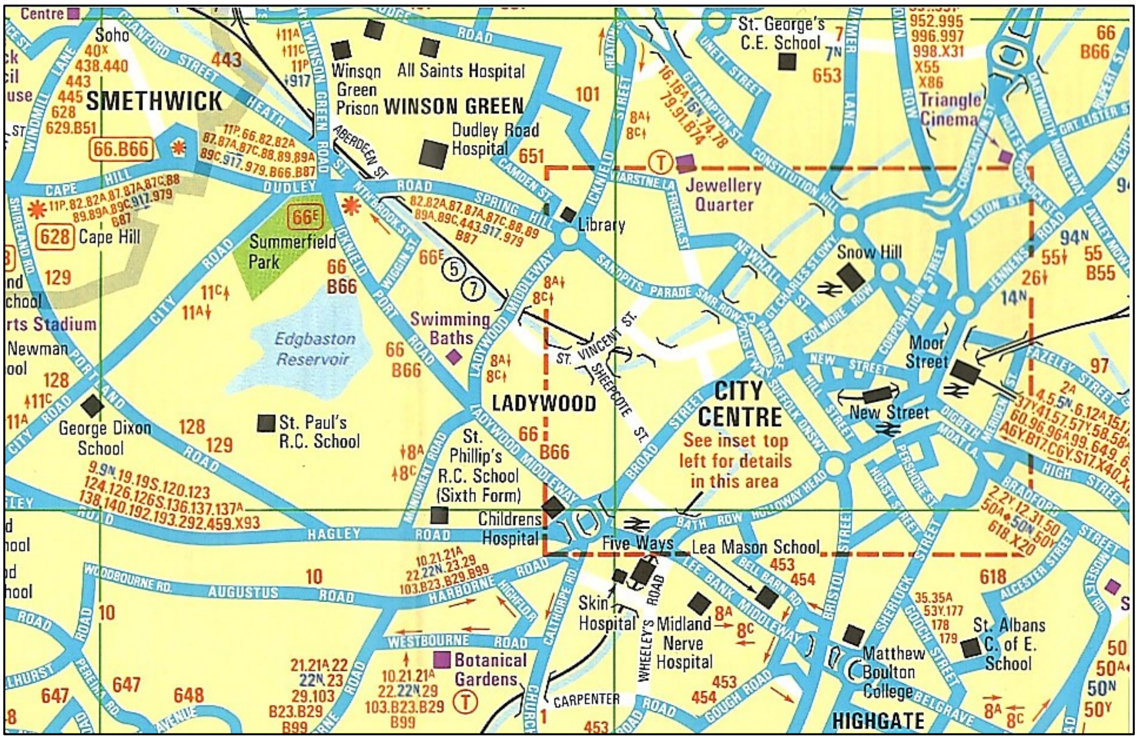

Figure 3.4: Geographical Approach bus map design (Source: Birmingham Centro's, 1993)

Figure 3.5: Bus map in the Geographical Approach map style (Source: Oxford Express 1995)

There are other specific differences in how cartographers represent the bus route in Geographical Approaches. The differences are categorised into three subcategories: the Full-road Network, the Main-road Only, and the Bus-route Only.

The first style is the Full-road Network. This style can be described as the style that directly takes all the main features and elements of a topographic or street map and includes all the extracted information as the background information of a bus network map. In the Full-road Network design, the bus routes or bus services are highlighted using distinctive colour. The colour(s) selected for the bus route(s) has a high contrast with the background colours. The bus service numbers are typically placed above the road. This style is exemplified by a transportation map from City of Brugge (Figure 3.6).

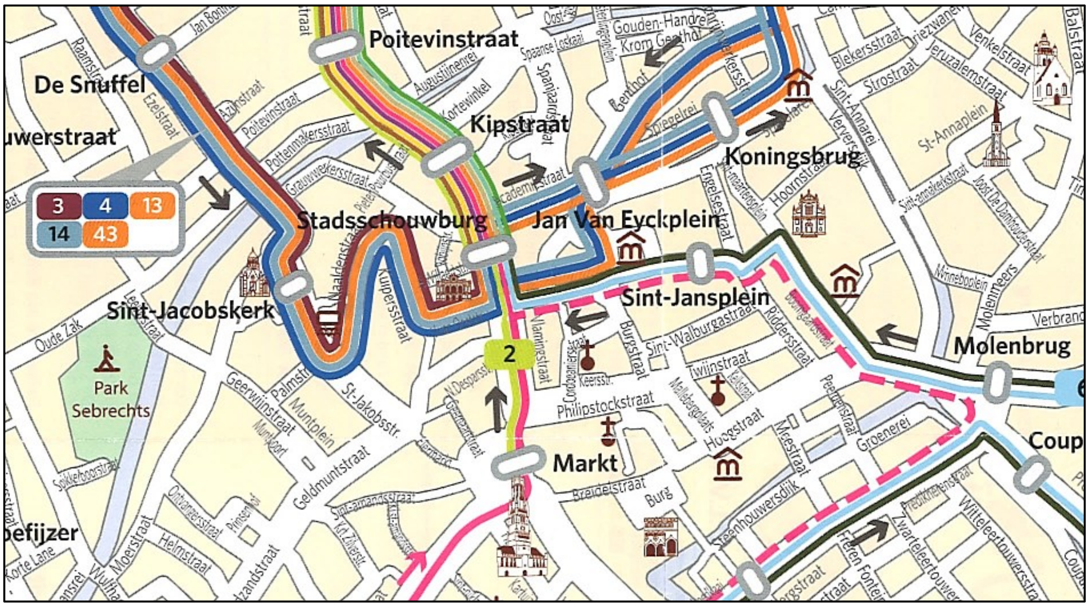

Figure 3.6: The Full-road network bus map design (Source: De Lijn's Brugge Centrum, 2016)

The 'Main-road only' style is another approach used in Geographical Approach bus maps. Here the roads with bus routes dominate the map, with perhaps a few other connecting road links, but most non-bus-route roads are eliminated. Other significant features, such as water bodies, open spaces, and rail lines, may also be included in the map, but not the Full-road network. The bus services numbers are placed alongside the roads to help users identify the bus services lines. An example can be found in a transport map from Glasgow, United Kingdom (Figure 3.7).

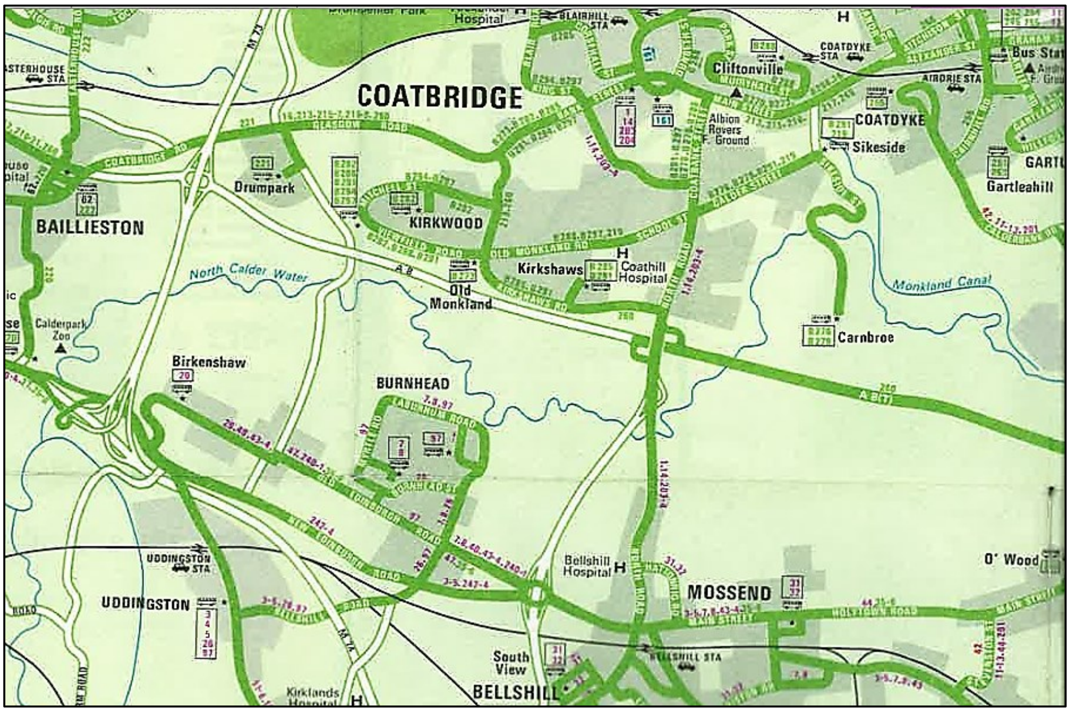

Figure 3.7: Main-road only bus map (Source: Greater Glasgow Transport map, 1975)

The third style in this Geographical Approach is the ‘Bus-route only.’ This style looks like the ‘Main-road only’ style, but the bus routes are the only features represented with intense colour in this style. The text, numbers, and labels are only placed on the bus service’s road (Figure 3.8). Background information may vary from being very subservient to non- existent.

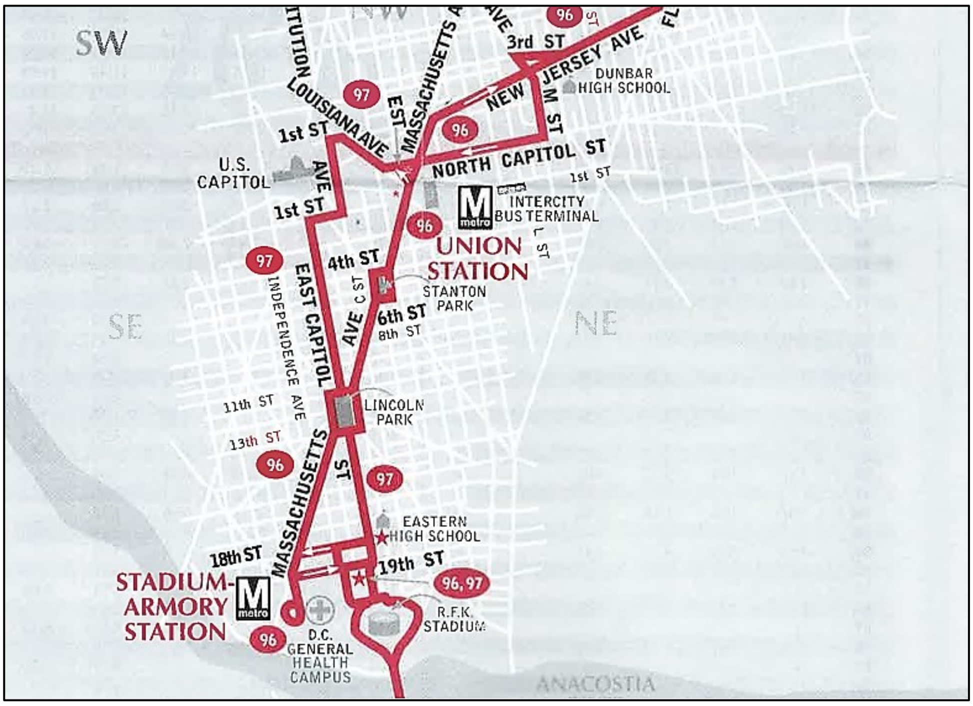

Figure 3.8: Bus-route Only bus map (Source: 96 and 97 Metrobus map, 2015)

3.4.2 Schematic Bus Map design

The schematic map style can be characterised as a map that depicts the transport route in various straight line forms, typically either in horizontal, vertical, or at 45 degrees declination (Morrison, 1996). It can be described as a linear cartogram with a specific purpose, as this style is very selective in depicting the spatial features of a route network (Oke and Siddiqui, 2015; Monmonier, 2018). Typically, a schematic style is presented as a not to scale map, which means that estimation of distance and directions on this type of map cannot be compared in the same way as in the Geographical Approach style map.

Schematic diagrams use symbolic representations of pathways to reduce complexity and ease orientation in a network. A node or a line will only define the relative topological position on the map in a schematic representation, which is not their accurate geographical representation on the Earth. Schematic maps emphasize placing only the simplified lines and other vital features of the transportation networks they want to portray, leaving the minimal representation of background information such as landmarks and other natural features, as shown in Figure 3.9.

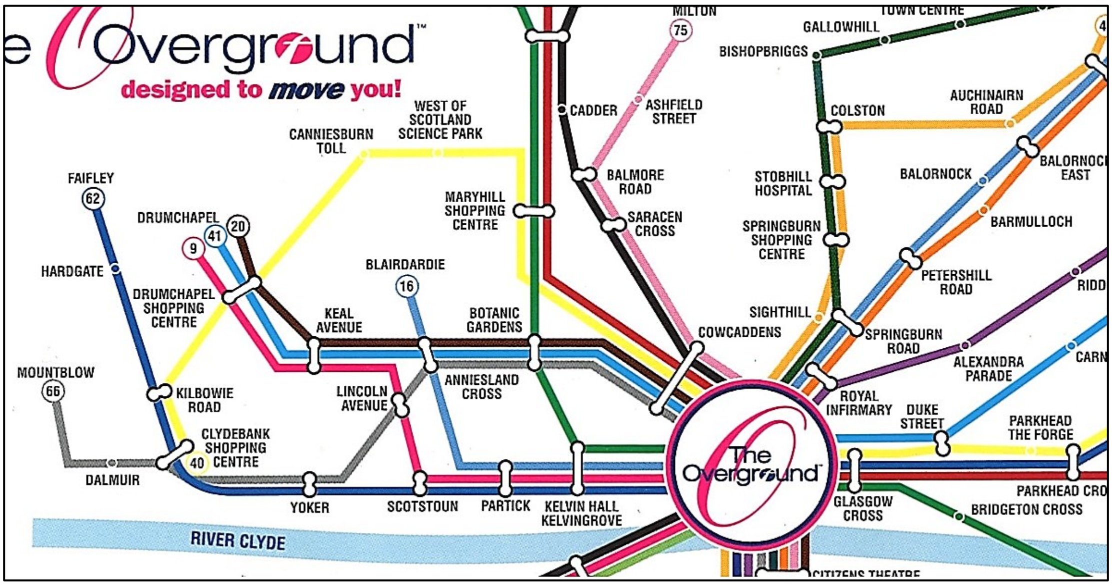

Figure 3.9: Glasgow Overground's Schematic bus map (Source: Overground Glasgow First Bus Map, 2012)

Schematic transport network maps often adjust the position of stations or stop to be evenly spaced between key nodes or junctions in the network, creating further differences from the area's actual geography. Public transport maps from Dresden, Germany (Figure 3.10), is an example of public transport map that adopted the Schematic approach design.

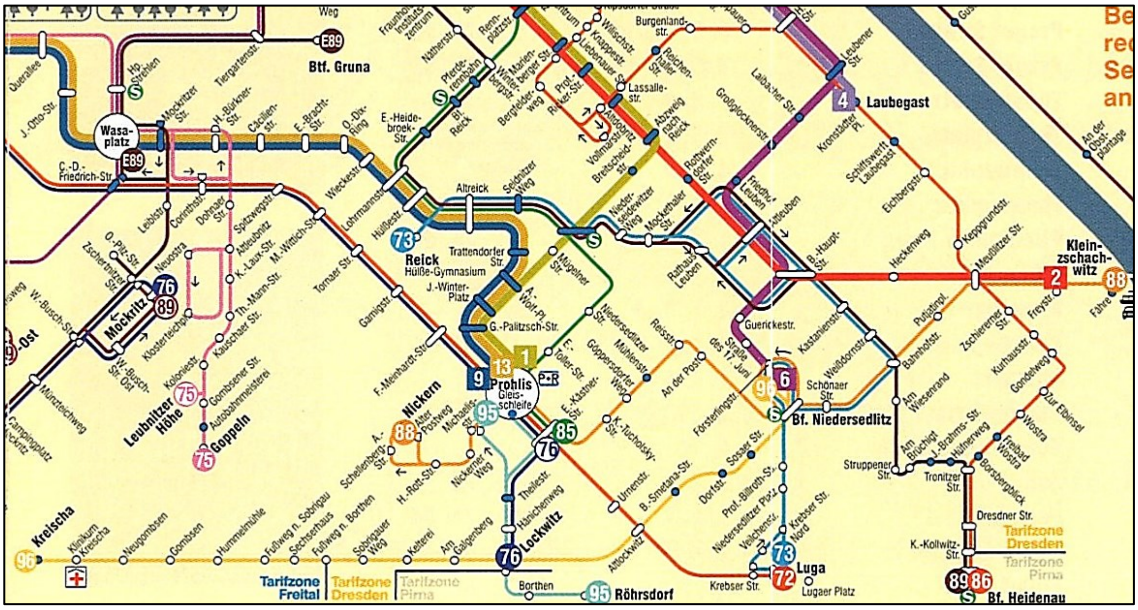

Figure 3.10: Schematic approach bus map design (Source: Liniennetz Dresden, 2013)

The use of schematized representation in bus maps can be divided into two major styles. The first is a full-schematic design and the second is the semi-schematic design. The full-schematic map style is well known and effective for metro systems, with the number of transport maps adopting this approach rising significantly in recent times. This trend was started back in the 1920s and 30s with Harry Beck's famous London Underground Map (Figure 3.11) being the most famous example (Roberts, 2012).

Figure 3.11: Harry Beck's London Underground Map 1932 (Source : (Londontopia, 2017)

In this map, Beck puts more emphasis on the legibility of the relative location of stations rather than the geographical accuracy. Beck's creation is based on the commuter's needs, who only want to know their arrival and departure station and any interchange stations (Garland, 1994). It makes sense since there are no other spatial references involved other than the railway track and the station's position when traveling underground. Commuters only need these two types of information to get to their location. However, Beck put one of London's most prominent natural features on the map, the Thames River, to help passengers orientate themselves.

The success of Beck's design was phenomenal and has inspired many mapmakers and influenced their transport map design (Glancey, 2015). Even though the Becks' design is well known and effective for metro systems – to the extent which some cartographers view as a masterpiece of map design (Guo, 2011) - there is a view that schematic maps as defined are not suitable for use for bus mapping (Morrison, 1996b).

Massimo Vignelli is one of the mapmakers that adapted Beck's signature work in his transit map design. However, his New York City Subway map is an unsuccessful example of a transit map created using Beck's design as the basis. In 1972, Vignelli designed his New York City Subway map, as shown in Figure 3.12. In his map, Vignelli adopted the same design principles used by Beck – in using colour coded routes at 45 or 90 degree and horizontal lines – but he took a more unconventional approach by symbolising water in beige colour, omitted the all-important New York street grid, and redefined the shape of Central Park. City residents promptly voiced their frustration against this inaccurate representation of geographical features (Rawsthorn, 2012). Tourists' problems worsened the frustration as they could not relate the map with the real features above the ground. By 1979, the city council replaced Vignelli's map with a Geographical Approach map style.

Figure 3.12: Massimo Vignelli's map for the New York subway (Source: Vignelli, 1974)

On the other hand, the semi-schematic design merges elements of the schematic map to locally simplify the representation but retain an overall Geographical Approach (Figure 3.13 and Figure 3.14). This design preserves several spatial accuracies of the transportation networks, but it still permits the modification and distortion of several aspects of the network to allow more apparent information delivery (Cain, 2007; Cain *et al.*, 2008). The location of network features is kept either at the original geographic position or near the original position. There are no drastic changes in scale or orientation. In this design, background information showing prominent features is far more extensive compared to the full-schematic style. The features shown do not just include essential natural features like lakes or rivers, but nearby street details and other prominent geographical features. If multi-modal transportation is included in a semi-schematic map, it will keep its clarity by combining multiple services with few lines and impose moderate scale distortion in certain areas shown in the map. In short, the semi-schematic design can be said to be a compromise between a full schematic map and a genuinely realistic geographical representation.

Figure 3.13: Bus map that uses Semi-schematic map design (Source: Bus Guide – New Forrest, Christchurch, New Milton, Ringwood 2010)

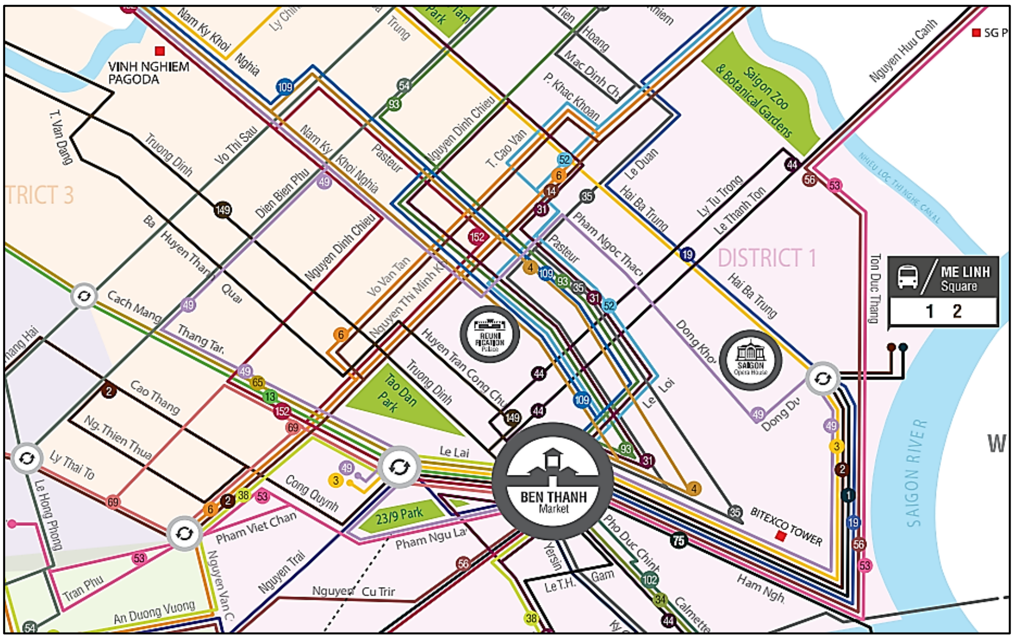

Figure 3.14: Bus map in the full-schematic style (Source: Ho Chi Minh City Bus Map, 2016)

There has been a surge of interest in the use of the semi-schematic style in public transportation maps. The continued growth of urban areas combined with the fast development of public transportation systems has stretched the capability to present transport networks in either Geographical Approach or Full-schematic design (Roberts, 2014). Different geographic locations need a different cartographical approach in representing the bus information to the users. The semi-schematic style offers a more flexible solution in portraying network information on a map without compromising the user's understanding of location; it re-enforces their existing mental map, rather than conflicting with it.

However, portraying a bus map system using a schematic design is not an easy task. The bus system does not have a similar spatial sense to a rail or metro system. Bus systems do not have a dedicated track, and their routes are mostly shared with other modes of transport. The distorted representation of geographical features in schematic maps is not ideal for a transportation mode that uses the street network as their main feature. It will also be complicated for a bus user who tries to compare the streets' reality with the bus route shown in a full-schematic design. Bus stops are typically more frequent and much less significant landmarks than railway stations. Also, they do not have the same naming convention as railway stations. All bus stops in one long road might share the same name, or cross streets or other landmarks be used to name them. However, the names are rarely displayed at the bus stop location. More recently, it is common for bus stops to be identified by a code, which can be useful in conjunction with on-line applications, but rarely shown on maps. Moreover, unlike railway or metro station names, this code is often not clearly visible without close inspection.

Morrison (1996) is not in favour of fully schematic design for a network bus map, and in his research, he singled out the several towns where experienced users rejected maps published in a full-schematic design.

3.5 Important Map Elements and Visual Variables for Public Transport Maps

Apart from defining the type of general map design approach, it is essential to evaluate every other important map element presented on a map. These map elements are discussed below.

a) Visual Hierarchy

An extensive bus map may consist of various coloured routes, multiple line styles, and different text to distinguish routes. These features appear against a background, which will affect their visibility and legibility. It is crucial for bus maps to have an excellent visual hierarchy with good contrast between route and background images, especially for bus maps in the Full-road network category. Background colours need to be carefully selected to establish the visual hierarchy of the map. The bus service routes should always be at the top of the hierarchy to highlight the map's primary purpose, and the background detail should always visualise as the least important feature of the map.

Morrison (1996) strongly advised considering grey as the predominant background colour as this will enable every colour other than grey to represent the transport routes. However, the decision made should not only based solely on the Morrison statement. The researcher believes that cultural factors should also play a part in choosing the colour. For example, in Kuantan, a local tourism maps shown in Figure 3.15 used multi-colour backgrounds to represent the types of land cover that shape the map background. This situation, over time, has created a map identity among the locals.

Figure 3.15: Kuantan’s Fun Map (Source: Pahang Tourism Board, 2016)

b) Grids

Grids are almost always seen in national topographic maps and are widely used in street maps and tourist maps. In the Geographical Approach, the grid can serve multiple purposes. Primarily it can be used to provide a spatial index to information on the map, such as the location of termini, interchanges, or landmarks (Cain *et al.*, 2008a). If an appropriate grid interval is chosen, the grid can help the user estimate distances between locations and perhaps some indication of possible travel time (at least when walking). Grids can also be used in Schematic maps to provide an index, but care needs to be taken to ensure the user does not associate the grid with regular distances on the map.

c) Presence of Waterbodies

It is interesting to investigate whether main water bodies should be included in a bus map as most cities - including most major cities in Malaysia - are centred around or near a water body. Whether to include or not to include the main waterbody feature can be made from a case of map representation conundrum. Back in 1933, Harry Beck highlighted water bodies as the most important background information after he preserved the River Thames as the only topographic feature in his London Underground map (Ovenden, 2005). However, a backlash over an unprecedented move by Transport of London (TfL) to remove the river in 2009 has further strengthened the claim that major water bodies should be included in a transportation map. TfL’s reason behind that move was to make the map look simpler and reduce user’s confusion as the transport network continued to expand over the years. The new version of the map lasted only three months before the River Thames was restored to the map after TfL received many overwhelming negative reviews about its removal, notably from London Mayor himself, Boris Johnson (BBC News, 2009). An investigation by Forrest (2011) confirmed that where a significant water body was present in a city, the majority of metro maps included it, even if no other topographic information was depicted in the surrounding area.

d) Scale, Scale Bar and North Arrow

Another commonly used map elements are a directional symbol and a scale bar. A North arrow often represents a directional symbol. It is interesting to find out if these two map elements' placements are essential for the bus map case, as the use of both map elements is not compulsory. They should only be used if they can heighten the user's understanding while using the map. A North arrow in a map will point out the direction of the map, maintaining the map's true direction within the map frame at the same time (Slocum *et al.*, 2008). On the other hand, a scale bar may be used to measure distances between two points on a map.

Most Geographical Approach maps should include a scale bar and should include a North arrow if North is not towards the top of the map. Clearly there can be issues with both these devices on highly schematised maps, in that both scale and orientation will vary across the map.

e) Inset Map

An inset map is a smaller map inserted within the main larger map (Slocum *et al.*, 2008). Inset maps in a bus map could have various purposes, including maximizing the view of a crucial area and engaging other information related to the map's information. It is also used to present another area that is outside the extent of the primary area. The inset map placement is not fixed to any position, as it is variably placed depending upon the map size, space available, the inset map purpose, and the arrangement of other map elements. It is not uncommon for larger scale insets to be located on the reverse of the main map, but this can make map use more difficult than locating it appropriately on the main face of the map, especially if detail is removed from the inset area on the main map.

f) Landmark Symbolization

A landmark can be described as a functioning reference point based on distinctive environmental features (Vinson 1999). A landmark is a prominent feature in every type of map form. The landmarks help to provide the background information that is needed by the map user. When using a bus map, the user will always try to find a feature on the map to start orientating themselves on the map. In addition to information such as the road names, area names, or water features (discussed above), cartographers commonly use landmark features to help users identify their location on a map. A landmark can give additional information on direction, distance, or relative location to the map's user.

There are various ways to symbolize the landmarks in a map. Landmarks can represent areas (such as parks woodland), or lines (such as rivers, viaducts), or point features. There are two types of symbol used to show the landmarks. The first type is conventional symbols, and the second is pictographic symbols. Conventional symbols can be described as commonly used and recognized symbols (such as those on topographic maps), while pictographic symbols look like real features.

In the case of a public transport map, a key point of interest vital to be highlighted is the name of the service termini. Morrison (1996) and Evans (2010) exemplified the importance of termini placement in their research by citing several misleading information cases due to the lack of termini name. Including the termini, the name will help the user follow the whole route of each bus service, from one end to the other. The lack of termini labels will likely cause problems, especially for a new user, in understanding what direction a bus service is heading. This scene could cause them to take the wrong bus even though the bus service number is correct. The destination or termini name is typically shown at the front of the bus. This good practice must be replicate by cartographers by placing the name of termini clearly on the map so that the user can link the information gathered from the map with the information carried by the bus signage.

3.6 Paper Maps and Digital maps

It is essential to choose the right medium to portray bus maps and information as the success in geographic information transmission and utilization is essentially linked to the medium on which it is created and displayed. So, if geographic knowledge is to be transmitted and utilized more effectively, the information must be developed and portrayed in the most efficient medium (Hurst and Clough, 2013).

A map is a visual representation of an area, either the whole area or part of it. The map's primary function is to show specific information about that area, which in this case, is the bus network information. Maps come in various mediums such as static maps or digital maps, two dimensional or three-dimensional maps (Monmonier, 2018). There are two main mediums used in providing public transport information. The first medium is through printed materials, a traditional way used by bus service providers to show their service networks. The second medium is through digital media, an option made possible by recent years' vast technological advancements. Due to this advancement, it is now easy to create and publish an online map. With numerous mobile and web applications, a map can be designed, created, and published to the user quickly. By early in this millennium, the daily number of maps distributed on the internet already exceeded the daily number of printed maps (Peterson, 2003), and the advent of the smartphone has made digital mapping ubiquitous. Digital map use has been made easier by integrating GNSS and other positioning systems into mobile devices and smartphones, making the use of location more accessible to all people (Hurst and Clough, 2013).

Digital maps can be published in either static or dynamic form. The static digital map combines the graphic variables assigned to a map and converts it into the electronic information form; it is in effect similar to a snapshot of a conventional paper map (Kidman and Chang, 2019). The dynamism in representing the network information allows more associated information, such as scheduling information, combined with the map image without any limitation of boundary dimension or space. This dynamism brings more convenience to the users as they can explore a large area with the highest detail of information possible with only one smart device in their hand.

Interactive media can be included in the map to help users in the wayfinding process. This interactive media can include a voice to guide users and a short video highlighting several landmarks on the map. The interactive map also enables the user to filter out any extra information that they do not want to use during any particular time of usage, thus creating a more focused map. Another significant characteristic of a digital map when linked to position and orientation sensors is the automatic self-orientating function. This function keeps the user on the map and can automatically rotate the map to the forward-up orientation (Pilskalns *et al.*, 2016). This characteristic proves vital for a person that has limited skills in map reading and will prevent them from becoming lost during the map use process.

On the other hand, paper maps continue function as an excellent medium to present geospatial information. They represent the data in a static and constant condition, which means there is no dynamic option of zoom in or zoom out or the option to quickly filtering any sort of data (Reilly *et al.*, 2006). Paper maps may require more cognitive effort from the individual in actively exploring a particular area or place. Paper maps can play an important role in developing a good spatial understanding of an area as they can show a high level of detail over an extensive area, whereas digital maps can only show the immediate surrounding of the current user location in detail. Showing larger areas, especially on mobile devices, requires a great deal of simplification and leaving off features such as important landmarks and other beneficial information. There are concerns that this could weaken cultural and geographic literacy, but such concerns are beyond this study's scope. Thus, paper maps are still extensively used and demanded by people, despite of the electronic options, due to several unique advantages that they hold over the digital mapping products (Ooms *et al.*, 2016).

3.6.1 Paper Maps for Disseminating Bus Route Information

Extensive research into the current digital maps has revealed that paper products' usability is still the main element in its continuing presence globally, albeit with all the new technology that makes it possible for most documents to be stored digitally (Bondarenko and Janssen, 2005). Paper has been the primary medium of communication because of the many qualities that make it a broad and effective medium, including its simplicity of use, transportation, and storage (Johnson *et al.*, 1993). The efficient yet straightforward paper map navigation and the flexible usage of the spatial layout are also positive contributors to the continuing use of paper maps (O'Hara and Sellen, 1997).

Paper maps enable people to see a large area at one time and eliminate the irritating feeling when scrolling around a digital map, especially in a low network coverage area or due to the use of lower specification digital devices (Pedersen, Farrell and McPhee, 2005). Hurst and Clough (2013) further highlighted that the other significant reason to have the final products in the form of paper maps is that we can read and use the paper map at any time without having to worry about technical difficulties with the mobile application, whether it is about running out of data plan, network coverage and the device's battery longevity. These findings strongly highlight the reason why the paper is still dominant over its corresponding digital media and why this research focuses more on the use of paper maps as the medium to portray its final outcome.

Paper maps continue to thrive, especially for navigation, which is the main purpose of bus network maps. Rainsford & Mackaness (2002) noted that one of the deficiencies for users in planning their bus journey through digital maps is the electronic devices' interface systems. The electronic device’s interface met user resistance, and the location maps were of limited use due to their limited size and limited screen resolution. The use of the large format and higher level of detail maps should eradicate this deficiency as it enables the user to have a better spatial understanding of the whole route during the navigation process (Field, O’Brien and Beale, 2011). Field et al. (2011) found that users managed to complete a navigation task with any form of a map, be it a digital or paper map. However, interestingly, the users who used digital maps tend to use a longer route to complete their journey, whereas the paper map users took the shortest route possible, highlighting the effectiveness of paper maps during the navigation process.

Understandably, the use of digital maps will continue to rise, but it is best to acknowledge that the paper maps still produce more practical support for navigation purposes (Field, O’Brien, and Beale, 2011; Hurst and Clough, 2013). The reliability and usability of paper maps are still better than digital versions, so many people continue to prefer paper maps (Pedersen, Farrell and McPhee, 2005; Collins, 2018).

3.6.2 Bus Map Size

Another essential factor that is important in the public transport map is the size of it. There is no single size that will please everyone, but the transport provider must attempt to portray the bus information that is at least appropriate for the intended use. In this review, the map's variation in size can be classified into two main categories: large (A3 size or larger) and small (smaller than A3 size). The majority use of the larger sizes is understandable as full network bus maps covering larger areas can carry a vast amount of information, which would be impossible to portray effectively on a smaller map. The amount of data presented in a map is one factor that contributes to the chosen size format.

However, the large size does not mean it is only used on the wall or notice board as the map often comes in a foldable form. These foldable forms enhance the mobility aspect of the map, make it much easier for the user to bring it along on the journey or store it in their pocket. There are various types of foldable form practised in the industry which can bring another aesthetic value to the bus map itself. One of the examples of this foldable map form can be seen in Figure 3.16. Here, a map in Geographical Approach design was originally printed in 435mm wide x 298mm long dimension. To improve the map mobility, the map has been folded into a smaller size dimension, 79mm wide x 154mm long, which make it very easy to fit in any trousers' pocket.

The schematized approach is well known for its ability to simplify the portrayal of the transit service and its whole alignment; thus, it is not surprising that schematized maps are often presented in smaller paper sizes without compromising the legibility of the map. Smaller maps can use simpler folding patterns (bi-fold or tri-fold) or folded smaller, even smaller than credit card size, as exemplified in Figure 3.17.

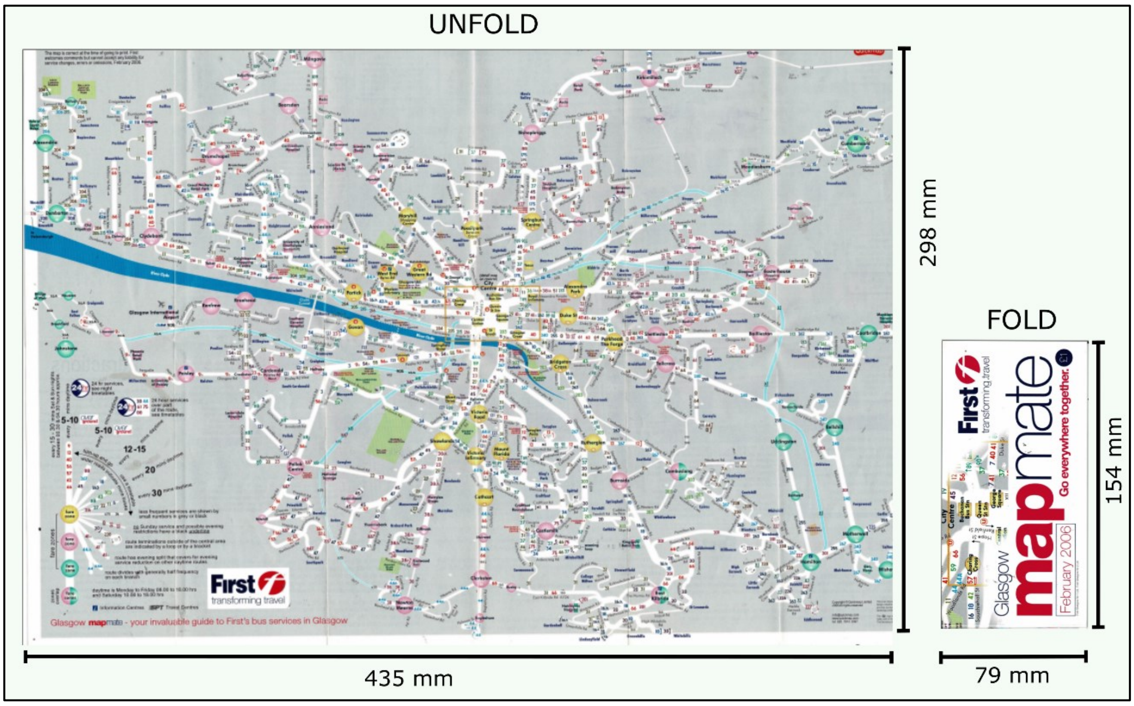

Figure 3.16: The size of foldable Geographical Approach bus map

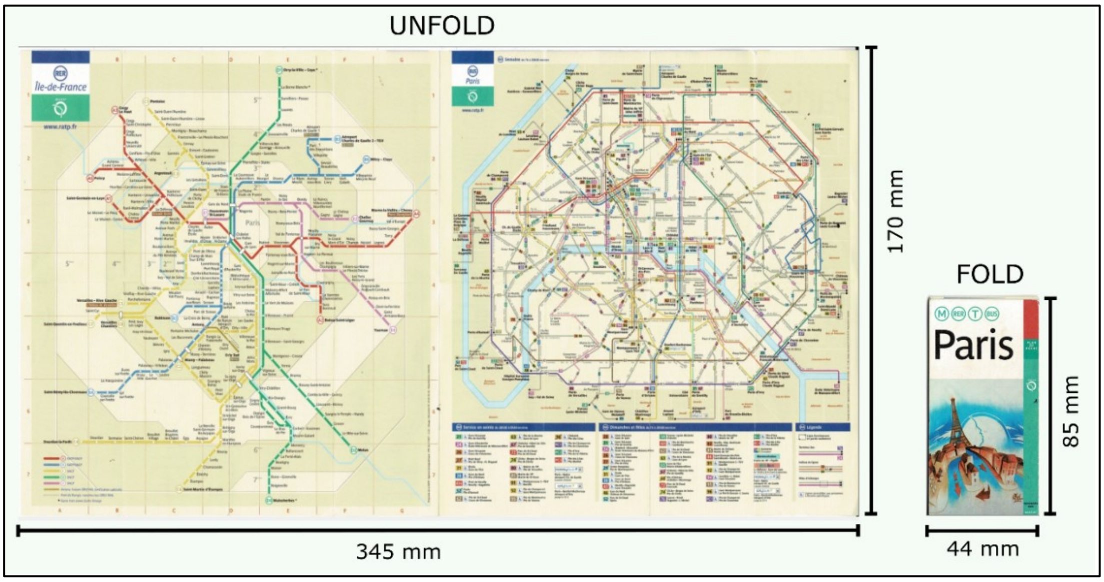

Figure 3.17: The size of foldable Schematic bus map

3.7 The Review on Bus Map Design

In order to prepare for designing sample maps for user testing, it was deemed essentially to carry out a thorough review of existing bus map products. Prior to commencing such a review, it is vital to have a precise definition of the review process in place. The focus must be on the actual user groups throughout the review. This situation will effectively lead the final products to achieve the research objectives. As such, the map review was carried out using the content analysis method.

The review draws on several disciplines that relate to the public transportation systems and to map study. Examining literature from diverse fields (psychology, sociology, GIS, transportation) helps the researcher understand how and in what ways that the user makes use of public transportation, how the systems are routed and planned, what current issues affect the provision of public transport information and other areas that might affect the design and application of a bus map.

3.7.1 Review Scope

This This review of published bus maps covers all aspects ranging from the focus on bus maps' cartographic design, current techniques of producing bus transportation maps, local culture about bus maps, and other relevant topics. A significant element of the review consists of a map critique that focuses on identifying the useful cartographic design features of existing public transportation mapping practices, which could be implemented to design the map products of this research, and poor practice, which should be avoided.

In carrying out this review, it is vital to acknowledge the different terminology used by different authors and organisations, often reflecting geographical location. In the UK, the term ‘public transport map’ is typically used to define the products of interest here, with ‘bus map’ focusing on one specific mode of public transport. In North America, typically, the term ‘transit map’ is used, which often refers to bus maps, but may apply to maps of other public transport systems or maps showing a combination of transport modes. In the review that follows, the terminology used follows the source referred to, but more generally, ‘public transport map’ or ‘bus map’ is preferred.

3.7.2 Bus Map Review Using Content Analysis Method

A study on past and current published bus maps needs to be carried out to help the researcher identify the cartographic techniques and representations used in bus map design. This study embarked on a detailed investigation that aims to understand the nature of different approaches in mapping bus routes and bus networks and how they can be applied efficiently in different bus transportation situations. To carry out a comprehensive review of current bus mapping, bus maps from various towns and cities - in both paper and digital format - were gathered from various official sources. This collection of maps was further supplemented by some older bus maps available to the researcher.

There are 55 bus maps obtained from the United Kingdom, European countries, and the United States of America. There is no limitation on the map’s published date as the author also seeks to find the variation in bus map design over time. The publishing dates of the maps included in this study ranged from 1975 to 2018. The sample was those maps readily available to the reviewer, comprising the maps from the researcher’s collection and Dr David Forrest’s map archive. The sample cannot be considered a comprehensive representation of bus maps published over the period but do represent a wide range of locations, publishers, and approaches to map design.

Each map was reviewed thoroughly using a method called content analysis. In general, content analysis is a method of systematically examining and evaluating symbols of communication, themes, and variation in materials (Suchan and Brewer, 2000; Rose, 2016). Previously, content analysis was primarily used for text analysis. However, recent literature shows that content analysis has been widely used to analyse published images or maps, to characterize prevalent themes in thematic map design, and to discover common technical practice (Kessler and Slocum, 2011; Muehlenhaus, 2011b; Riffe, Lacy and Fico, 2014; Roth, Quinn and Hart, 2015). Content analysis can be divide into qualitative content analysis and quantitative content analysis (Krippendorff, 2018). This research adopted the quantitative content analysis (QCA) concept in gathering frequency data, which can reveal the prevalence of map design patterns based on the appropriate creation of map design categories and codes.

Riffe, Lacy, and Fico (2014) defined QCA as "the systematic and replicable examination of symbols of communication, which have been assigned a numeric value according to valid measurement rules, and the analysis of relationships involving those values using statistical methods." Among the cartographic research that utilized similar QCA methods are a study on revealing the importance of cartography in American journalism (Monmonier, 1990), a study on understanding the variations in thematic map design (Muehlenhaus, 2011a), a study to discover the map design pattern and composition of persuasive maps (Muehlenhaus, 2013), and a study on identifying the design principles for origin-destination flow maps (Jenny *et al.*, 2018).

3.7.3 Developing Analytical Categories

The content analysis method is reliant on precisely defined categories and codes. With these set categories, it allows researcher to quantify nominal level data for statistical analysis and ultimately find out the similarities and differences in each map composition (Muehlenhaus, 2013). Categories are the practical rules that determine the intensities and definitions of different elements in the analysed maps. The objective of using categories is to enable systematic evaluation and analysis for every map and reduce reviewer bias. For the technique to be efficient, the categories must be explicitly created and thoroughly apply to the maps. As such, all the map elements were categorized and coded into several classes. The creation of categories is the most critical aspect of content analysis. These categories were created based on public transport map design guidelines and other cartographic research discussed in Chapter 2.

The categories created in the map evaluation form must adhere to three requirements. First, the categories must be comprehensive, covering all the aspects needed by the research. Second, each category must be independent of one another, meaning each aspect cannot be categorised twice for the same map. Third, the categories must be informative (Rose, 2016). The evaluation and review process for this research was carried out on the basis of the categories defined in Table 3.2.

Table 3.2: The map design categories and definition

PART 1	**GENERAL INFORMATION**	**DESCRIPTIONS**
1.1	Map ID	Individual ID for each map
1.2	Map Title	The original title for each map
1.3	Publication Date	The year the map was published
1.4	Publisher	The Map Publisher
1.5	Map Location	The depicted location of the map

1.6	Data Source	Map provider
1.7	Map Size	The size of the paper used to present the map. Divided into two main categories: Small (Smaller than A3 Size) Large (A3 Size & larger)
1.8	Map Coverage Area	The region covered by the map
1.9	Map Intended User	The target end-user
1.10	Use of Space	Space covered by the map on the paper
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Availability of the element (yes or no)
2.2	Presence of Scale Bar	Availability of the element (yes or no)
2.3	Projection Information	Availability of the information (yes or no)
2.4	Presence of Grids	Availability of the element (yes or no)
2.5	Presence of North Indicator	Availability of the element (yes or no)
2.6	Presence of Legend	Availability of the element (yes or no)
2.7	Legend: Completeness	The level of information placed on the legend section, in terms of completeness, text legibility and type of graphical symbol shown
2.8 2.9	Legend: Legibility Legend: Symbol-likeness	
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	There are two general types of map design classified in this research: 1. Geographical approach 2. Schematic approach
3.2	Type of Geographical Map Design	The specific type of Geographical approach map design: 1. Full-road Network 2. Main-road only 3. Bus-route only
3.3	Type of Schematic Map Design	The specific type of Schematic map design: 1. Full-schematic 2. Semi-schematic
3.4	Category of the Full- Schematic Map Design	The specific type of Schematic map design: 1. Tetralinear to Hexalinear 2. Various Octolinear 3. Decalinear to Curvilinear
3.5	Number of Transportation Modes Shown	The number of Transportation Modes included in the map: 1. Single-mode 2. 2 to 4 modes 3. More than four modes

3.6	Element Use to Differentiate Between Mode	Type of visual variable used to represent information
3.7	Element Use to Differentiate Between Service Line	Type of visual variable used to represent information
3.8	Is bus Number shown on the route?	Availability of the information (yes or no)
3.9	Element Use at Overlapping Situation	Type of visual variable used during overlap situation
PART 4	**BACKGROUND INFORMATION**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Availability of the element (yes or no)
4.2	Hierarchical Level Meet the Map Purpose?	Researcher evaluation (yes or no)
4.3	Boundary Level Shown: Country Border	Availability of the element (yes or no)
4.4	Boundary Level Shown: District Border	Availability of the element (yes or no)
4.5	Boundary Level Shown: City Border	Availability of the element (yes or no)
4.6	Presence of Hydrographic Feature	Availability of the element (yes or no)
4.7	Hydrographic feature: Legibility	Researcher evaluation (clear or not clear)
4.8	Hydrographic feature: Contrast	Researcher evaluation (clear or not clear)
4.9	Presence of Road: Main Road	Availability of the element (yes or no)
4.11	Presence of Road: Minor Road	Availability of the element (yes or no)
4.12	Presence of Road: Other Road	Availability of the element (yes or no)
4.13	Presence of Road: Railway/tram/metro route	Availability of the element (yes or no)
4.14	Presence of Road: Footpath	Availability of the element (yes or no)
4.15	Presence of Landmark	Availability of the element (yes or no)
4.16	Number of Landmarks	Researcher evaluation (many – few)
4.17	Inset Map Availability	Availability of the element (yes or no)
4.18	Inset Map: Category	Type of inset map
4.19	Does Inset Map meet map purpose?	Researcher evaluation (yes or no)
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour: Efficiency	Researcher evaluation (yes or no)
5.2	Colour: Colour or Black and white	Type of colour used
5.3	Colour: Enhance Map Usage?	Researcher evaluation (efficient - unsatisfactory)
5.4	Line: Number of Line Types	No of Line Types shown: 1. Less than 2 2. Between 3 to 5 3. More Than 5
5.5	Line: Legibility	Researcher evaluation (Clear or Not Clear)
5.6	Line: Contrast Level	Researcher evaluation (Clear or Not Clear)
5.7	Line: follow the feature's shape?	Researcher evaluation (yes or no)
5.8	Typography : Font size	Researcher evaluation (Small, Medium, Large)
5.9	Typography: Legibility	Researcher evaluation (Clear or Not Clear)
5.10	Typography: Contrast	Researcher evaluation (Clear or Not Clear)

5.11	Typography : Placement	Researcher evaluation (Suitable or Not Suitable)
5.12	Typography: Numbers of Text	Researcher evaluation (many – few)
5.13	Symbology: Shape	Type of symbology used: 1. Conventional 2. Intuitive
5.14	Symbology: Explanation Given?	Availability of the element (yes or no)
5.15	Symbology: Explanation on Abbreviation	Availability of the element (yes or no)
5.16	Symbology: Legibility	Researcher evaluation (Clear or Not Clear)
5.17	Symbology: Contrast	Researcher evaluation (Clear or Not Clear)

Overall, there are 64 map design categories developed. To organize collection and analysis, the categories were separated into five groups. The groups are general information, map elements, map design, background information, and visual variables. The group separation is based on the type of information or map elements represented in the maps. The first group is general information. This group contains all the essential background information about the map. In this part, first, every map was assigned with a unique identification number. All the essential background information of the map, such as publication date, publisher, and map title, were included as a category in this part. The map's size was also added as one of the categories to help identify the map size pattern. In this review, the map's variation in size was classified into two main categories: large (A3 Size or larger than A3 size) and small (smaller than A3 size).

The second group contains categories related to the essential map element. This part investigates whether the map contains all the necessary map elements in their representation. Among the elements to be investigated are scale, scale bar, projection system information, north indicator, and legends. The legends were divided into three more categories for a more detailed evaluation of the legend's content and arrangement.

The third group contains categories associated with the main map design elements. The categories included are the type of map design, whether in the geographical or schematic style. Categories were added to examine the subcategories of the two main map design styles. Further categories were created in this group to record the public transport information included. There will be various individual bus route services in a public transport network map and, sometimes, multiple transportation modes and the bus service. There are multiple design variables possible, with cartographers commonly using colour, number (text), line style, or combining these three variables to differentiate the modes and the routes. The final category was added identify the visual variable(s) used to represent the mapping information in a conflicting or overlapping situation.

The fourth group contains all the categories linked to the maps' background features and information. Additional background information needs to be included in the map to help users put the bus services in context. The background information level needs to be carefully considered, so it is not too much, confusing the user, or making it difficult to find their selected bus line. Nevertheless, it should not be too little, or the user will not know how to orientate themselves when using the map. This is one specific area where bus maps' design varies from metro and rail maps' design. Metro and rail systems typically have fewer but very clearly named stops, so little additional information is required for user orientation. Bus systems typically have more stops, but the stops are much less distinctive than rail or metro stations, so users need additional information to confirm their location.

Finally, the fifth group contains categories developed to evaluate the map's graphic elements' effectiveness and visual variables used. Four types of elements/variables were selected as the main categories: colour, line type, typography, and symbology. These categories were based on the crucial graphic elements found in previous transit map design guidelines and cartography research (Higgins *et al.*, 1999; Denmark, 2000; Association of Transport Co-ordinating Officers, 2003; Cain *et al.*, 2008a). For colour, the evaluation is based on the effective use of colour and whether the colour selection will help support the intended map use. For line style, the assessment was made to measure the line representation's clarity and how many line types were included in the map. For the typography setting, again, the evaluation was made to rate the clarity, to identify the size of the font used, and to assess the density of text placement on the map. Finally, the representation of symbology was evaluated. The evaluation is based on the types of symbology used in the map, the clarity, and any explanation for each symbol. The template of the map evaluation form can be seen in Appendix C.

3.7.4 Performing Content Analysis

The process of performing content analysis is very subjective. There is no specific technique or software to perform the whole process (Muehlenhaus, 2011a). The fundamental component of successful content analysis is concentration and consistency throughout the entire process. This study used the two software packages – SPSS and Microsoft Excel – to perform the data entry process, conduct analysis, and ultimately present the findings. A map evaluation form was created using the spreadsheet in SPSS to ease the data input operation. Registering data into each design category is quite a tedious process. It is imperative that the assessor remains focused during data entry as the validity of research data depends on it. All the registered data were then subject to quantitative data analysis.

Through the detailed comparison of each category of map design and comparison of map design categories with other related design categories that have been similarly coded, the resulting contrasting instances have helped the researcher to refine the concept of every bus mapping system involved and ultimately have a view on the most popular and common practice in mapping bus networks. The details about the map review on the 64 design elements are presented in the next section.

3.8 Review and Analysis of Bus Maps

As mentioned previously, properly formulating and presenting adequate transportation information in just a single map may not be easy, especially with the rapid development of cities around the world and the advancement of bus transportation systems. With the current cartographic representation variations used in bus maps, map makers will have a better perspective on delivering the right information in the most appropriate style in a given situation.

The fifty-five evaluation forms produced for the analysis are included in Appendix D. For better comprehension evaluation is presented in three-tier levels. Figure 3.18 shows the general framework in presenting the bus map design analysis. The first level of distinction that has been identified is between Geographical Approach bus map (Geo bus map) and Schematic Bus Map. These two main level distinctions are further categorised into specific map types. The Geographical (Geo) bus map design can be further categorised into three subcategories, while the Schematic Bus map was further categorised into two subcategories.

Next, the second-tier represents the analysis of the level of map design elements shown in the maps. Here, the descriptive analysis of six map design elements in all 55 bus maps was dissected and presented. The visual variables shown in the map was further analysed into three subcategories, which give a vital overview of how the selection of visual variables is used in different map situations. Finally, the third-tier focuses on the landmark symbolization analysis. The landmark analysis was presented in two categories. The first category is the density of landmark appearance in each map, while the second category analysed the type of landmarks commonly used in the maps.

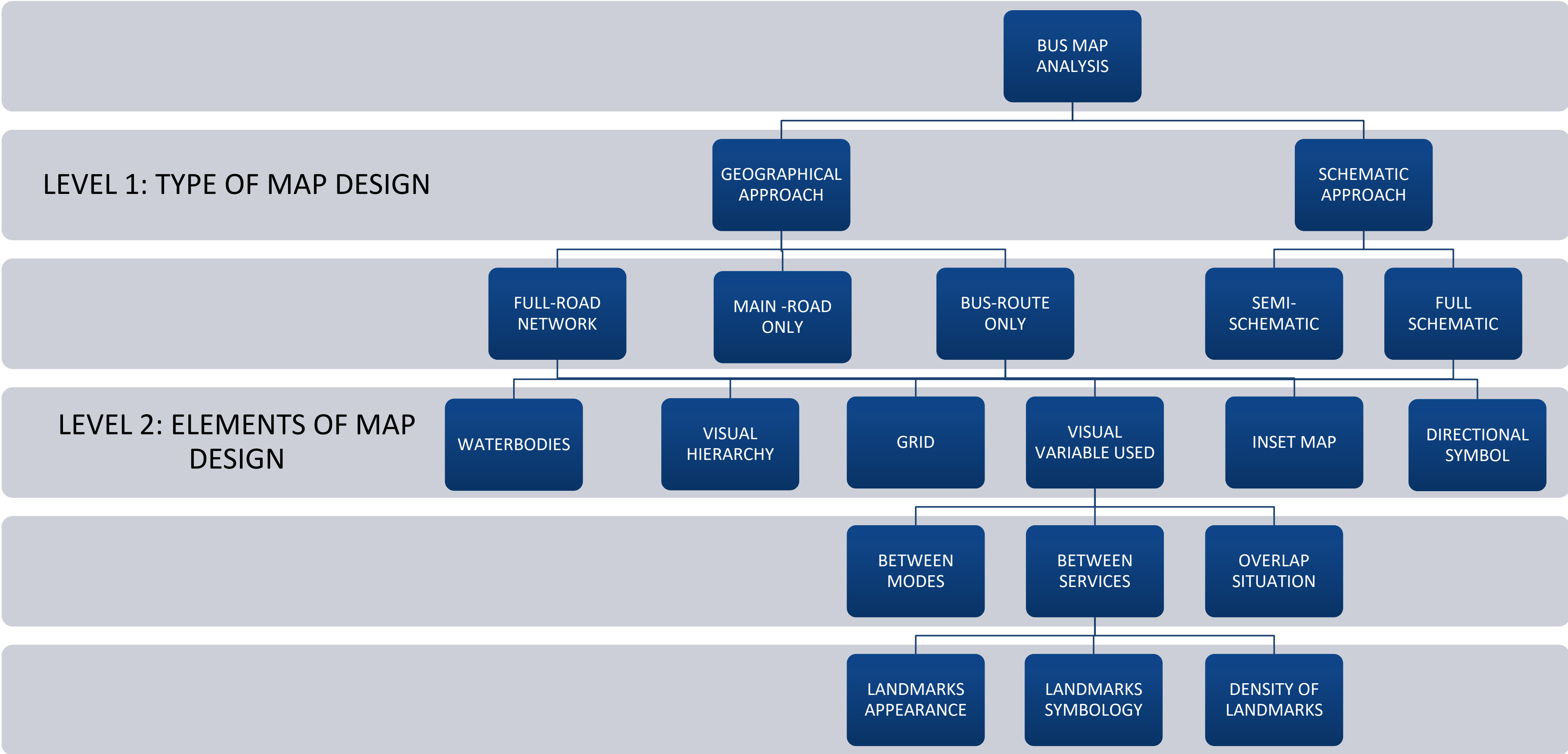

Figure 3.18: The framework of the bus map design analysis

3.8.1 Type of Geographical Approach Bus Map Design

Based on the map review conducted using the content analysis method, the Schematic approach has been the most popular choice in designing a bus map in the past, especially after the year 2000. Slightly more than half the bus map (56%) in this sample is in some form of schematic, with the majority published after the year 2000. In general, there was no clear preference between the Geographical approach and Schematic approach, with 44% using the geographical approach style and 56% using the schematic style.

Geographical (Geo) bus map design can be further categorised into three subcategories, which are the Full-road Network, the Main-road Only, and the Bus-route Only. It is found that the most popular style is the Full-road Network. 67% of the Geo bus map in the sample adopted this style in presenting their information. The Main-road style is the second most popular style with 24%, and the least popular style is the Bus only style with 7%. In the Full-road Network design, the bus routes or bus services highlight them using distinctive colours. The colour(s) selected for the bus route(s) has a high contrast than the background colours. The bus service numbers are typically placed above the road.

3.8.2 Type of Schematized Representation Used in Bus Maps

From the maps studied, it is found that when cartographers use the schematized representation, they tend to use the full-schematized approach rather than the semi-schematized approach. In the sample, 64% are of a full-schematic design compared to only 36% of the Semi-Schematic design. The surge in the usage of both kinds of schematized representation for bus maps can be seen to start from the year 2010. This may be tied in with the availability of software to generate such representations.

3.8.3 Bus Map Size

Another critical factor that is important in the public transport map is the size of it. There is no single size that will please everyone, but the transport provider must attempt to portray the bus information that is at least appropriate for the intended use.

Seventy per cent of the Geographical Approach map designs use the large size in presenting the bus map information, with the remaining 30% using small sizes. The majority use of the large paper size is understandable as full network bus maps can carry a vast amount of information, which would be impossible to portray effectively in a smaller map. The amount of data presented in a map is one of the factors that contributes to the chosen size format as it is found out that majority of the maps presented in large format use the Full-road Network Design approach (56%) rather than the Main-road or Bus-route only map design. However, the large size does not mean it is only used on the wall or notice board as the map often comes in a foldable form. These foldable forms vastly enhance the mobility aspect of the map, make it much easier for the user to bring it along on the journey or store it in their pocket. There are various foldable forms practised in the industry that can bring another aesthetic value to the bus map itself.

In Schematic Bus Map design, the large size was not the most commonly used size, with less than half of the maps being the large-size format (46%). There is a significant number of schematic maps in smaller sizes (54%). The schematized approach is well known for its ability to simplify the portrayal of the transit service and its whole alignment; thus, it is not surprising that more schematized maps were presented in smaller paper sizes without compromising the legibility of the map. Smaller maps can use simpler folding patterns (bi-fold or tri-fold) or folded smaller, even down to credit card size.

3.8.4 Elements Used to Differentiate Bus Services from Other Transport Modes or Bus Services

In a public transport network map, there are various individual bus route services and, sometimes, multiple transportation modes and the bus service. There are multiple design variables possible with cartographers commonly using colour, number (text), line style or a combination of these three variables use different modes and routes.

In the Geographical Approach map, the combination of colour and line style was the preferred choice generally and across the three specific types of geographical bus maps. Fifty-two per cent of the maps studied used this combination, and it is the most popular choice across all the types of Geographical Approach. This combination gives more options for the map-maker to differentiate between the transport modes presented in the map.

As we can see from Figure 3.19, the rail lines are represented in green colour while the bus routes are yellow. The added distinctive line styles of each mode make the difference very clear to the user.

Figure 3.19: Use of colour and line style for transport mode differentiation (Source: SPT Visitors Transport Guide,1997)

The use of only one variable, either colour or line type, is the second most used approach for this purpose. In the bus map case that shares with other transportation modes (such as trains and trams), the cartographers often use colour as the variable to separate transport modes. The broad range of possible colours makes this option the most comfortable choice for the cartographer to create a distinctive representation for each transportation mode. For example, in Figure 3.20, the cartographer uses two different colours (red and blue) to distinguish between Tram service routes and Bus service routes.

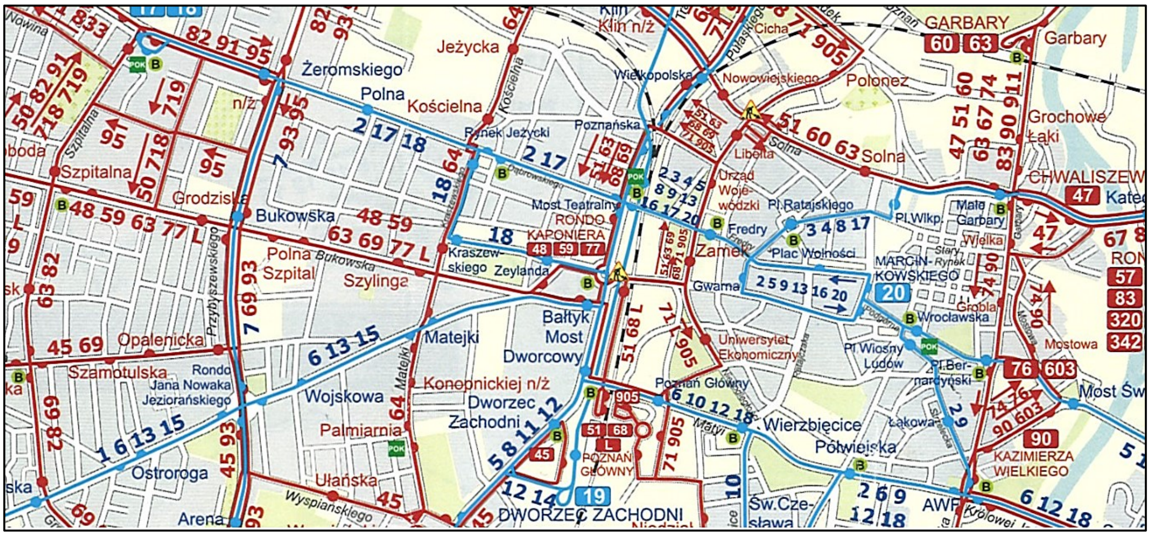

Figure 3.20: Use of colour for transport mode differentiation (Source: Map Network Connections ZTM Poznan, 2014)

There are four different design variables used to differentiate modes of transportation in schematized bus maps. The variables used are the colour, number, line style, or combination of two of these. In this category, a combination of these variables is not the most common method (32%) as cartographers tend to use colour (50%) as the only variable to differentiate between transport modes. The range of possible colours enables cartographers to provide a distinctive appearance to several transportation modes.

For example, a map that differentiates the transportation mode using the colour difference can be seen from the Virginia Metro Bus System map (Figure 3.21). In this map, the train and the bus are differentiate using colour. A bus map from Chicago (Figure 3.22) shows line style and colour to differentiate between the train and bus mode. The trains have a different colour used to represent their routes (various intense colours) and were represented in a thick line, while the bus routes use a low contrast colour with a narrower line width. The least used feature to differentiate transportation modes in schematized maps is line style. In the Ile de France transport map (Figure 3.23), both the train and bus systems are represented by the same colour, red, with the different modes indicated by the line width.

Figure 3.21: Differentiation using colour in a Schematic map (Source: Metrobus System Map – Virginia, 2015)

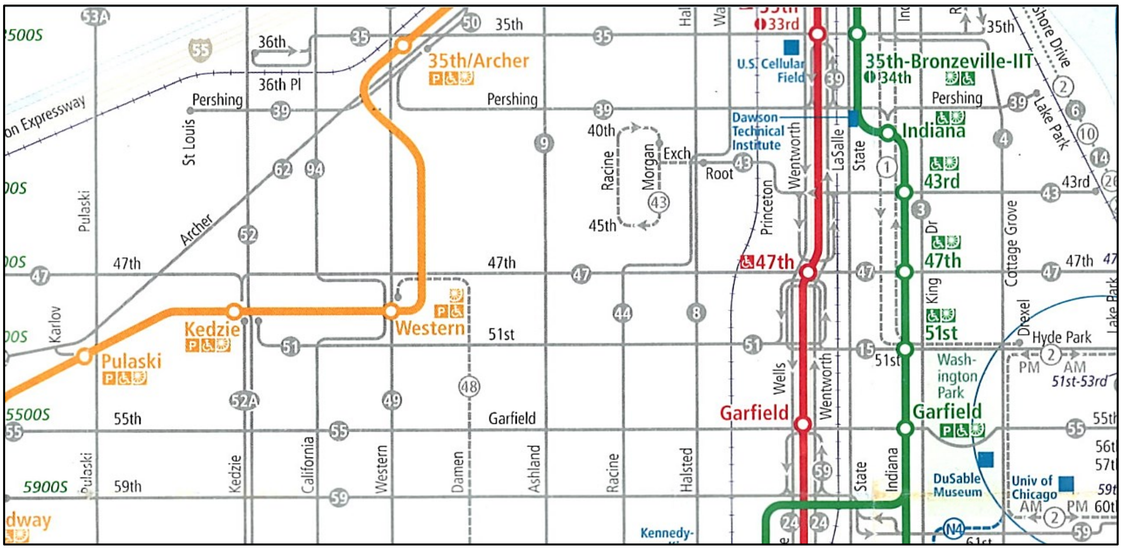

Figure 3.22: Differentiation using a combination of methods in a Schematic bus map (Source: Bus and Rail Map, Chicago Transport Authority, 2010)

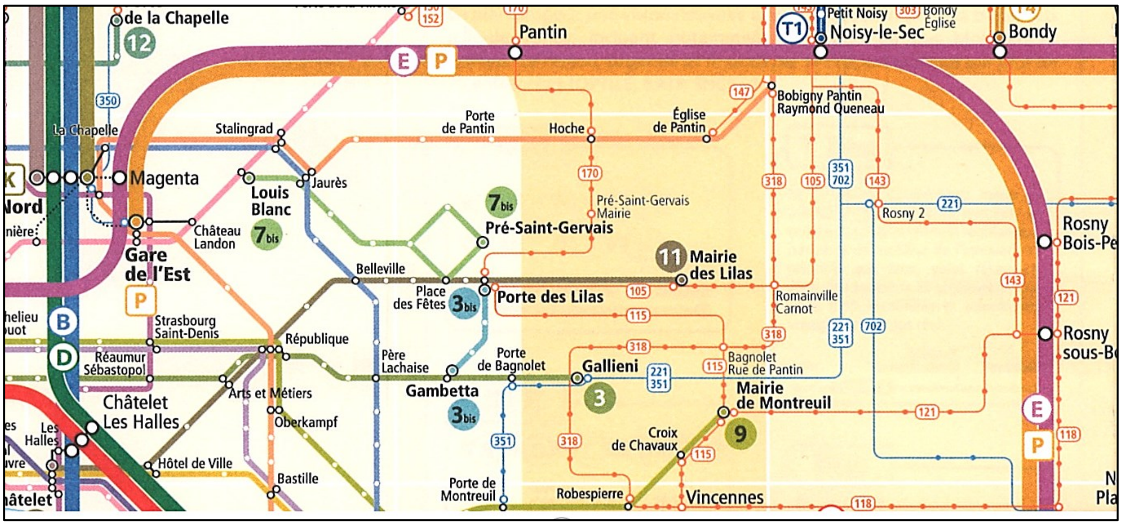

Figure 3.23: Differentiation using line style in a Schematic bus map (Source: Les transports en Ile–de–France 2011)

3.8.5 Elements Used to Differentiate Bus Services from Other Bus Services

For Geographical Approaches, colour is the most commonly used variable in differentiating the bus services or bus routes, with 44% using this. It was closely followed by the use of route number labels with 37%. The combination of these variables is the least used with only 18%. These findings are slightly different from what we have found previously on the type of variable use to differentiate different transport modes in Geographical Approach bus maps.

One example of colour usage to distinguish bus services can be found in a map from Washington (Figure 3.24). Here, four colours (green, yellow, red, and blue) are used to individualize four different bus services. Colour is the only feature that changes while other variables, such as line type, remained the same.

Figure 3.24: Differentiation of system routes using colour (Source: The Washington DC Circulator,2015)

The second popular method used by cartographers is to label the route with numbers or text. As the number of bus services shown increases, variations in colour or style become insufficient. Before the year 2000, the service number usage to differentiate the bus services were widely used. As we can see from the Oxford Bus Company map (Figure 3.25), the service lines are shown in the same colour throughout the map. The only way for the user to know their service line is through the placement of service numbers placed above the lines and shared the same colour as the bus routes.

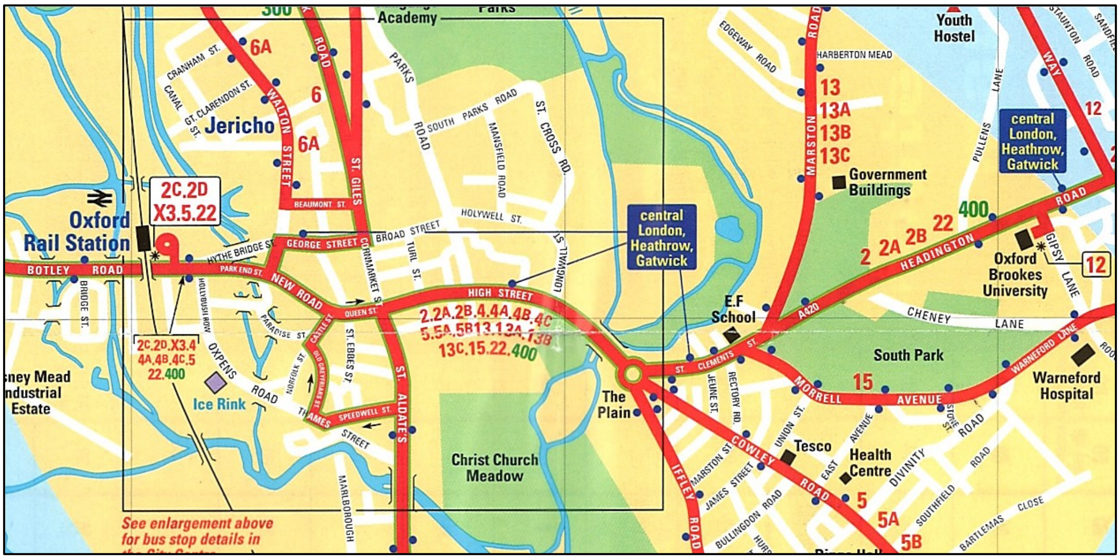

Figure 3.25: Differentiation of routes using text (Source: The Oxford Express 1995)

Another method practised in Geographical Approach maps is to combine the route number and route colour. In this case, the distinctive aspect can be found in the bus service's colour. Every road being used as the bus service route has bus service numbers, and the numbers are coloured based on the respective bus service. A bus map from London (Figure 3.26) is one example that shows how this combination of features works.

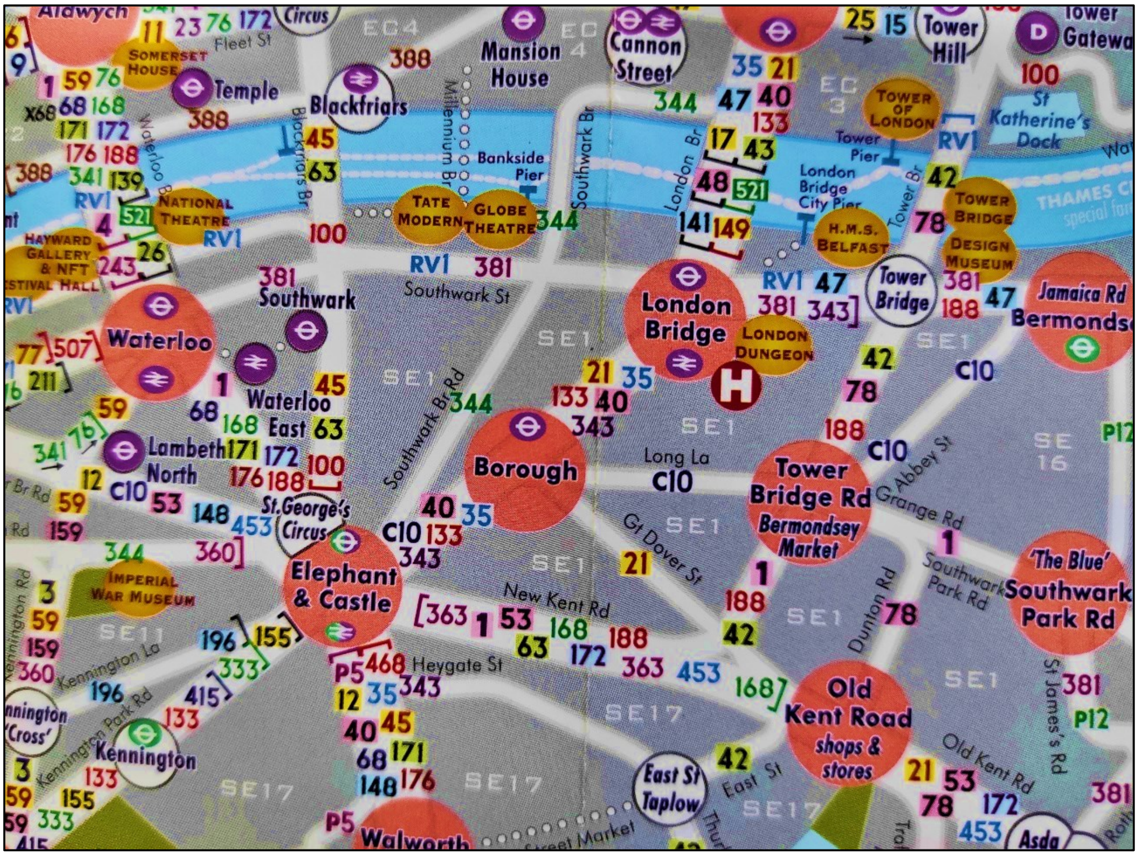

Figure 3.26: Differentiation using a combination of colour and text (Source: London by Bus 2011)

In Schematized bus maps, the most common method used to differentiate bus services is colour. Half the schematic maps analysed use this method. The bus route number placement is the second most common way, with 32%, and a combination of several variables is the least with only 14%. This selection is different from the Geographical Approach, where combinations of two or three variables are widely practised.

As exemplified by a bus map from Paris, France (Figure 3.27), a wide range of colours represent bus service routes. In this case, a different colour was assigned to each different service.

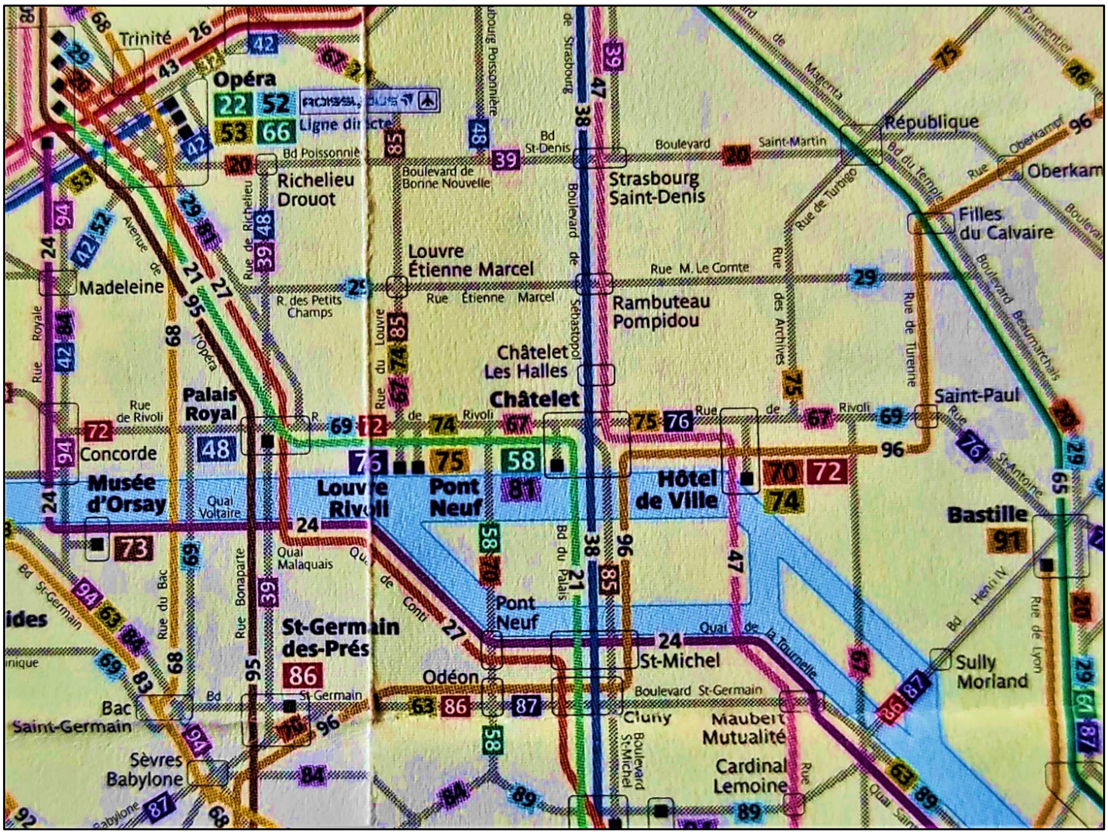

Figure 3.27: Use of colour to differentiate bus services line (Plan de Poche – Paris, 2005)

The number (text) feature is the least used method to differentiate bus services in schematized bus maps. Figure 3.28 shows that the same colour represents bus services. To know the respective bus services, users need to read the label (number) placed over the route lines.

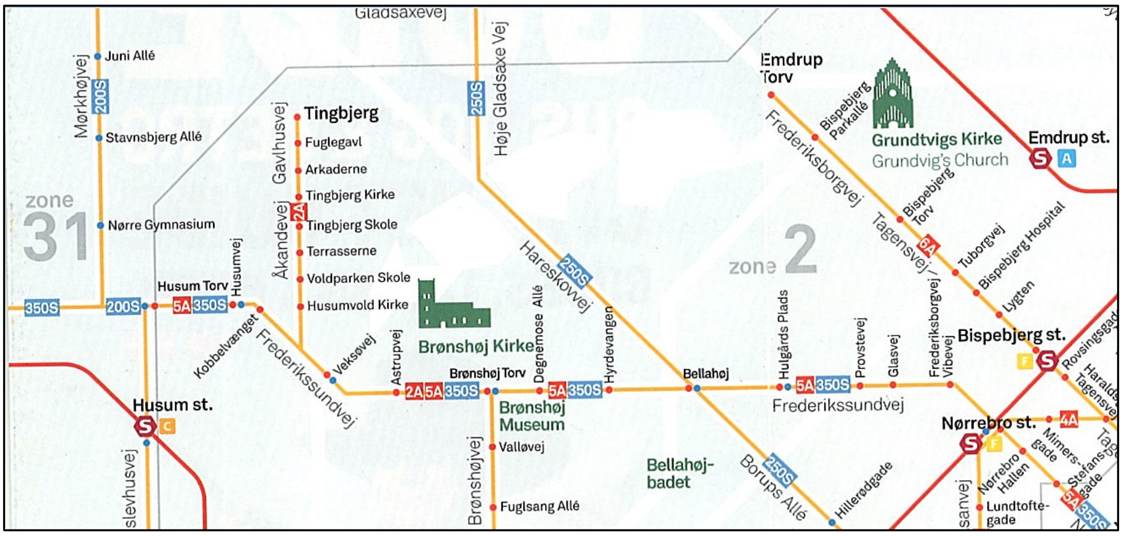

Figure 3.28: Use of text to differentiate bus services line (Byens Net Copenhagen, 2009)

3.8.6 Background Information: Level of Visual Hierarchy.

In Geographical Approaches, as shown in Figure 3.29, more than half (70%) show an excellent visual hierarchy from the maps analysed. However, not all bus maps have successfully portrayed the visual hierarchy as almost one-third of the maps (30%) do not show a fair visual hierarchy.

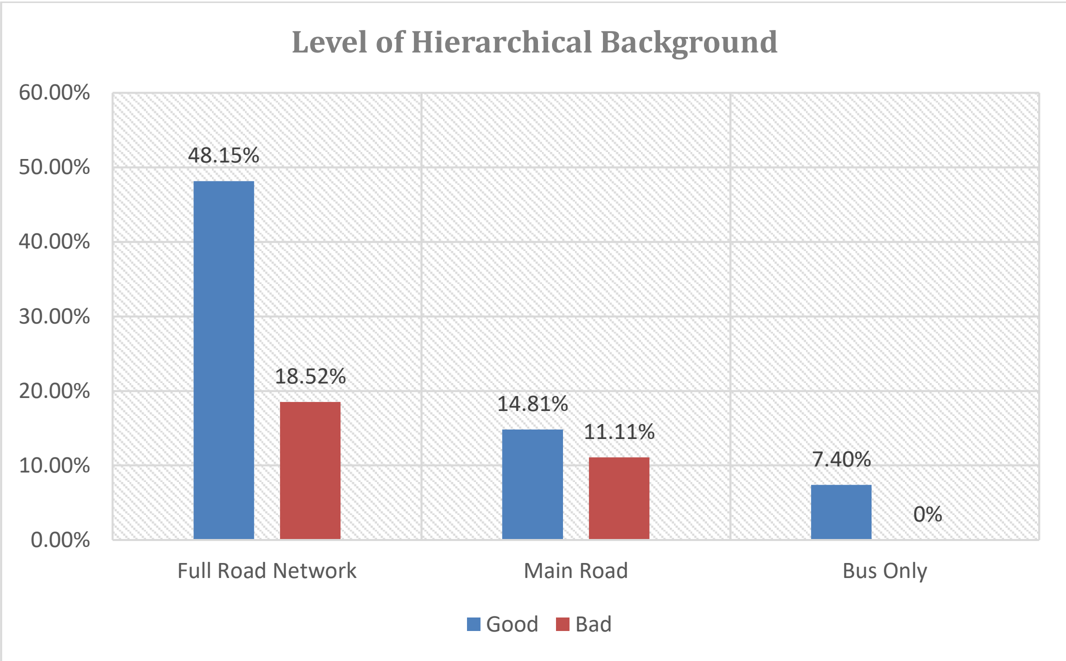

Figure 3.29: Visual hierarchy on Geographical bus maps

An example of a Geographical Approach bus map with good visual hierarchy can be seen in a bus map from the City of Glasgow (Figure 3.30). This map uses a multi-coloured background, but we can still clearly see the separation between the bus routes and other features on that map. Even though one of the colours used to define bus services is like that for the river and these features overlap at some points, the bus service routes can still be identified clearly.

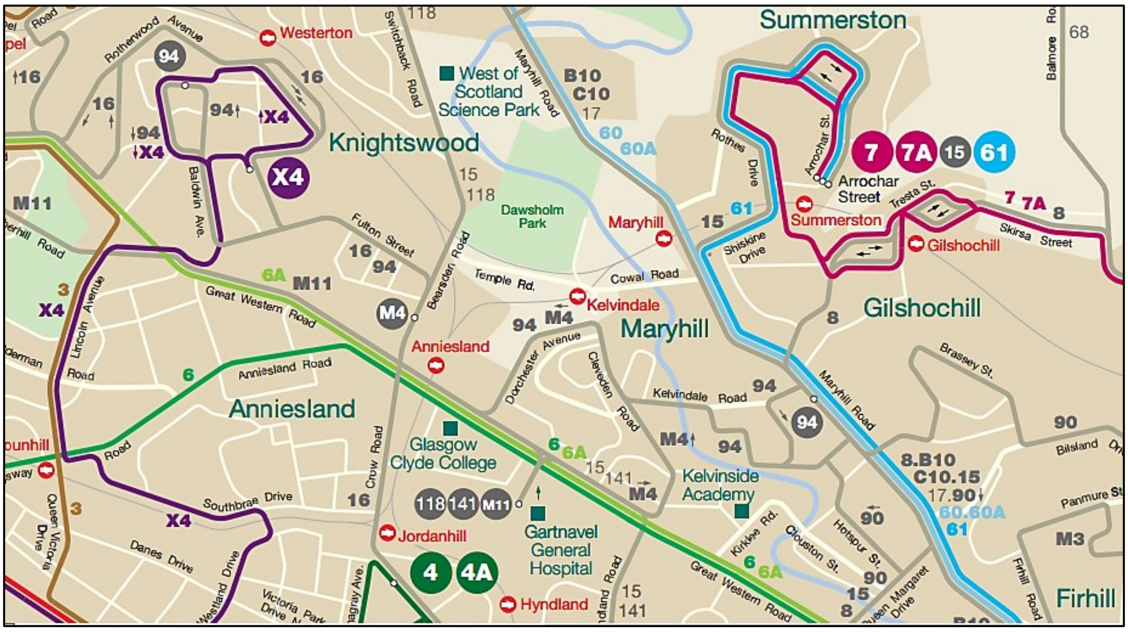

Figure 3.30: Good hierarchy level and background image (Source: Glasgow First Bus Network Map, 2018)

Edinburgh's transport map shows how a low visual hierarchy can affect the map readability process (Figure 3.31). This map predominantly uses colour lightness variations to show both routes and background, which does not provide sufficient contrast. This situation could lead to confusion while using this bus map.

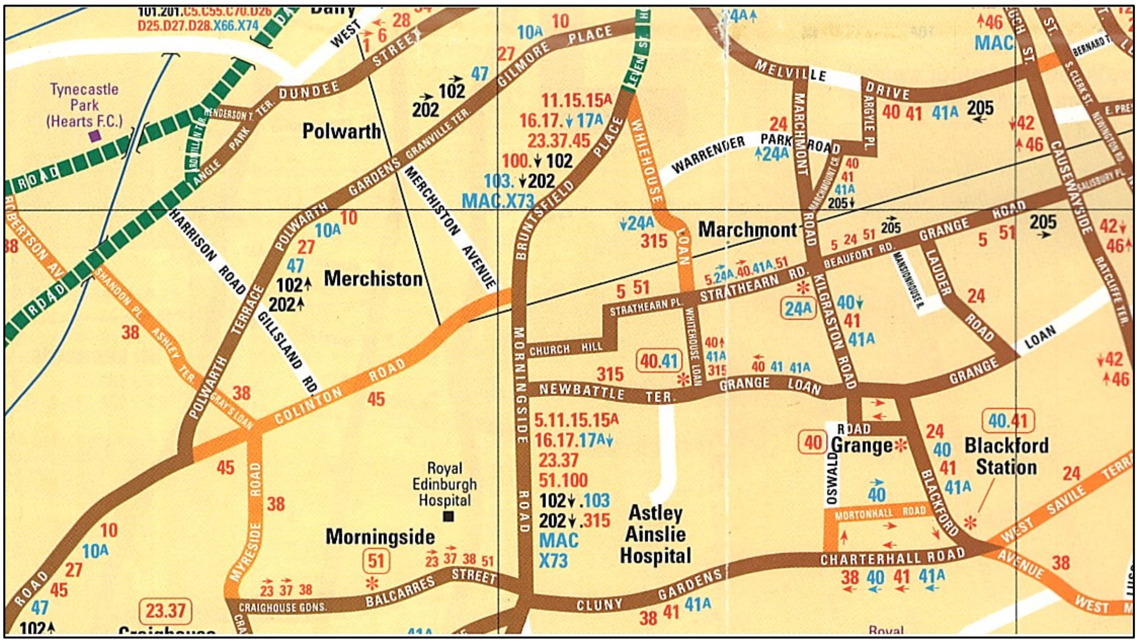

Figure 3.31: Poor hierarchy and background image (Source: Edinburgh Travel Map, 2010)

For the schematized map, similar to Geographical Approach maps, to help users understanding, additional background information may need to be included. The background information level needs to be carefully considered, so it does not hinder the user from finding their selected bus line or seem too little so that the user does not know how to orientate themselves during the usage of the map. There is the added complication in schematics maps of distorted geography, which can make the shape of geographical features unrecognisable.

There is a stark contrast between the appearance of hierarchies in full schematic style and semi-schematic styles. As semi-schematic maps may adopt the design and style used in Geographical Approach maps, the presence of a visual hierarchy can be seen in all semi-schematic maps examined. Generally, 57% of the schematic map shows a good visual hierarchy level, with semi-schematic maps, contributing almost 75% of good visual hierarchy maps to that figure.

One good sample can be seen in Figure 3.32. In this map, the bus service lines are shown with intense contrasting colours. The colours look very different from the background. Despite the multi-colour background, the user can still see the bus service lines clearly, and the background colours help them when using the map. This scene indicates a good hierarchical level of representation. The network of main roads also being included as background information further helps the user in orientating themselves.

However, this situation is not the same in some examples. As we can see from the Dresden Bus Map (Figure 3.33), even though this full schematic map focuses on the bus service routes, the reader may still find it difficult to see the route due to the low contrasting level of colour between the highlighted routes and the colour used as the background. Purple's use to represent lines over a light blue colour in the background does not provide good contrast. This situation worsened by the use of light red for some of the text features. The user needs to give more attention and focus while using this map.

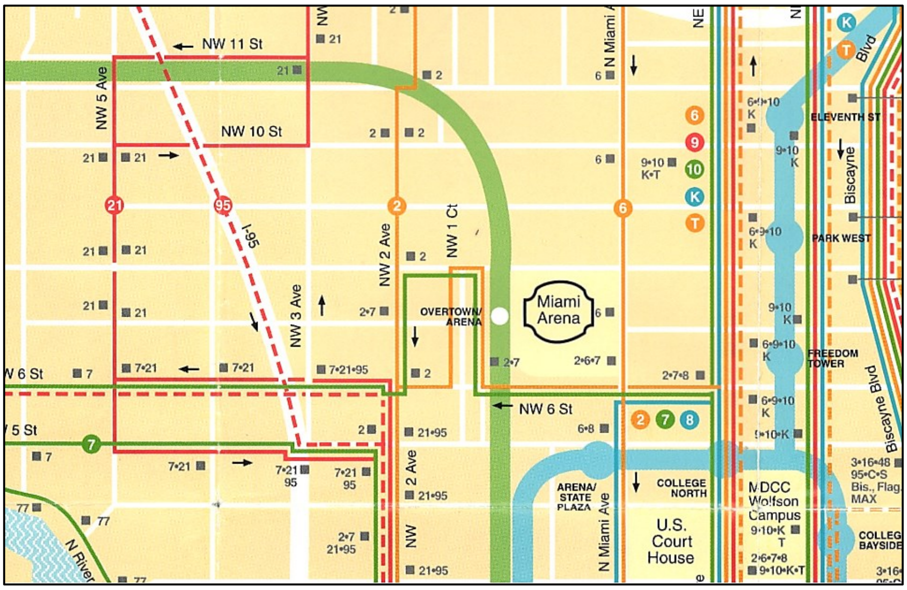

Figure 3.32: Good hierarchical level in a Semi-schematic bus map (Miami-Dade County Map,1996)

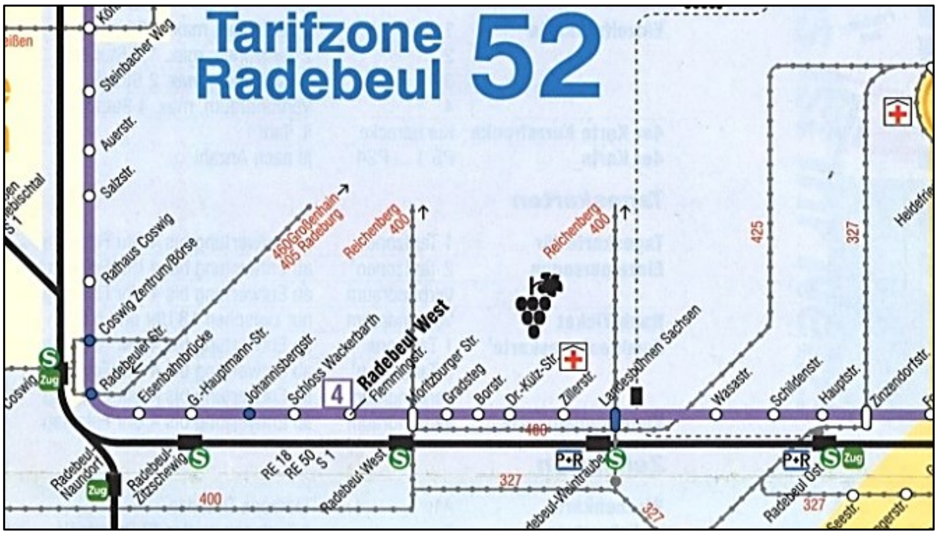

Figure 3.33: Poor hierarchical level in a Schematic bus map (Dresdner Linien, 2008)

3.8.7 Background Information: Grid Appearance

In the Geographical Approach, the grid can serve multiple purposes. It can primarily provide a spatial index to information on the map, such as the location of termini, interchanges, or landmarks. If an appropriate grid interval is chosen, the grid can help the user estimate distances between locations and perhaps some indication of possible travel time (at least when walking). From the map analysis, it was found that grids are not widely used in bus maps. In the geographical bus map design, the grids can be seen in 44% of the maps, with the notable presence of grids only found in the Full-road Network map style.

Among the Full-road Network style maps that use a grid as part of the background information are Edinburgh's bus map (Figure 3.34) and Geneva (Figure 3.35). Both maps were presented in a large format. The grid's presence will help the users in finding any location on the map.

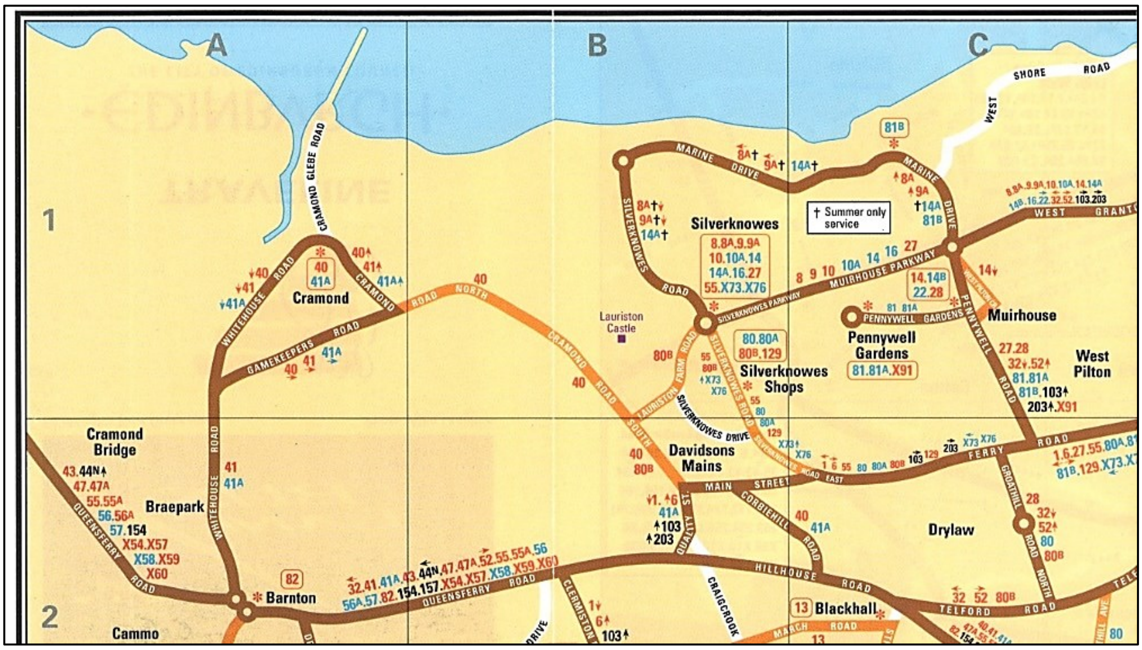

Figure 3.34: Grid representation on the bus map (Source: Edinburgh Travel Map, 2010)

On the other hand, grids are not extensively used in schematized bus maps. As schematized maps may have a high degree of distortion during the schematized process, adding a grid may not help determine absolute locations. A grid is only useful for indexing information on the map, such as tabulating the start and endpoints of routes or an index to other useful features. For schematic maps, only 30% have a grid, with most only included in the semi-schematic style; a style which often adopts several geographical maps' characteristics.

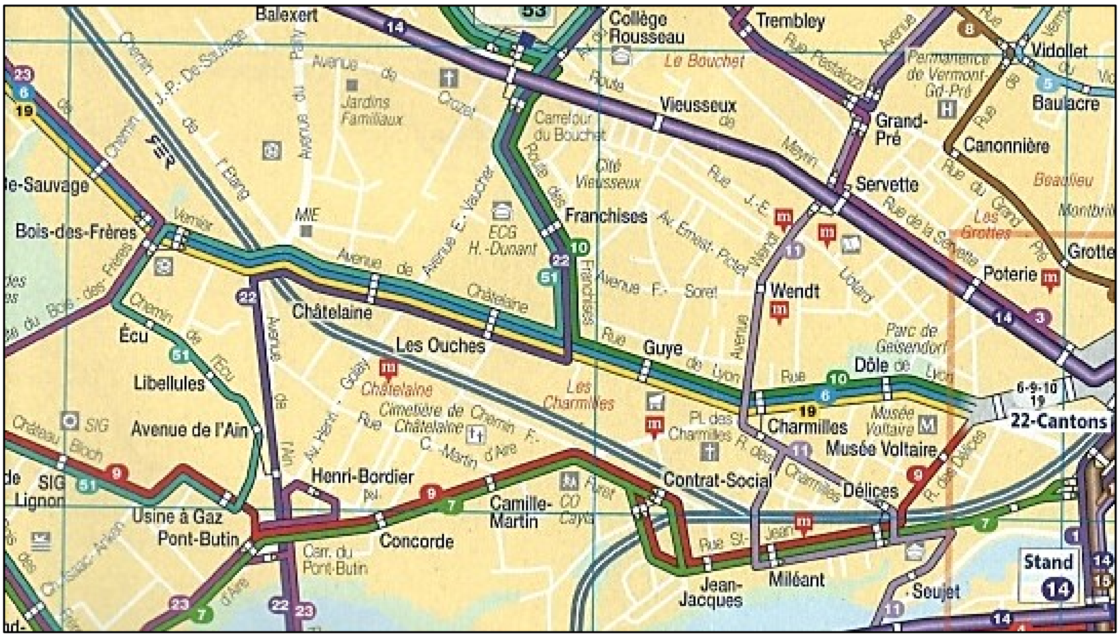

Figure 3.35: Grid representation on bus map (Source: Genève Plan De Reseau, 2012)

A public transport map from Brussels, Belgium (Figure 3.36) is one of the full schematic maps that does include a grid as one of the map elements. However, due to the extreme map distortions, the purpose of grid use is limited. The grid could offer help in indexing the map's information but would fall short in determining the actual distance of a journey, between one place to another, as the actual distance shown in the map are varied in each box of the grid represented.

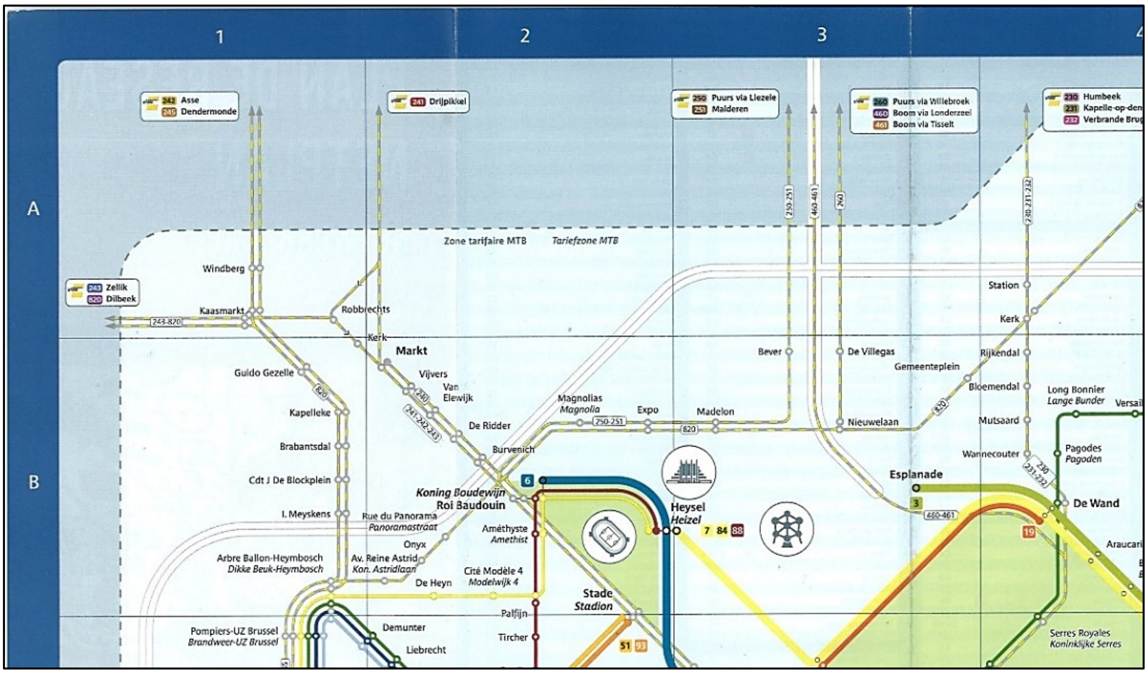

Figure 3.36: Presence of grid in a Schematic transportation map (Source: Brussels Plan de Reseau, 2016)

3.8.8 Background Information: Presence of Waterbodies in Bus Map

Based on map reviews, almost 90% of Geographical Approach bus maps include the main water bodies as part of the topographical information. However, this presence was slightly reduced for the Schematic Approach, where only 75% included the main water body. All the maps that do not contain the waterbody features were of the Full-Schematic bus map style. Contrastingly, all the semi-schematic style maps do include major water features.

Several maps exemplified the vital presence of the waterbody elements in a map. A Geo bus map from Poznan (Figure 3.37) included almost all waterbody features found on the ground. This map includes the main river and a lake, and other small ponds located in the coverage area's parks.

Figure 3.37: Presence of water bodies in bus maps (Source: ZTM Poznan Transit Map, 2012)

An unusual combination can be seen on a bus map from the City of Southampton, United Kingdom (Figure 3.38). In this map, the water body's presence was symbolized in the right geographic form of the water body itself, with significant detail, even though the bus route map is semi-schematic.

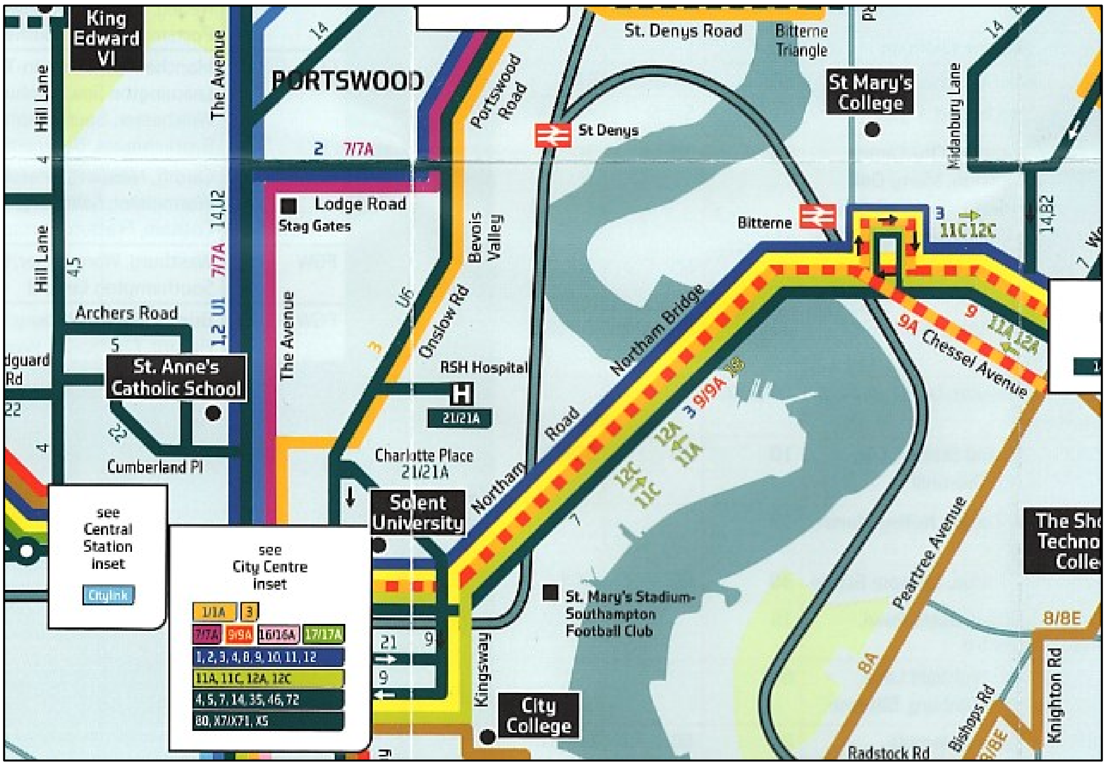

Figure 3.38: Presence of Waterbody in Semi-Schematic Bus Map (Source: Public Transport Map of Southampton, 2010)

3.8.9 Directional Symbol and Scale Bar in Bus Map designs

The north indicator presents in just over 40% of Geographical Approach bus maps. The situation is the same in the Schematic bus maps, which is surprising as schematic maps often distort directions.

The scale bar received the same fate as the North indicator as only 40% of Geographical maps include the bar scale. The Schematic approach bus map less frequently show a bar scale, with only 8% of maps including the bar scale. Understandably, far fewer schematic maps include bar scales as schematic maps tend to vary in scale, sometimes significantly, in a single map or made with no proportionate scale, thus limiting the bar scale's real purpose.

A bus network map from the City of Bruges (Figure 3.39) is one of the maps that does not include any of these map elements inside their map. It is determined that this Geographical Approach map was orientated in the true north direction and on a proportionate scale, but neither map scale nor directional symbol was depicted.

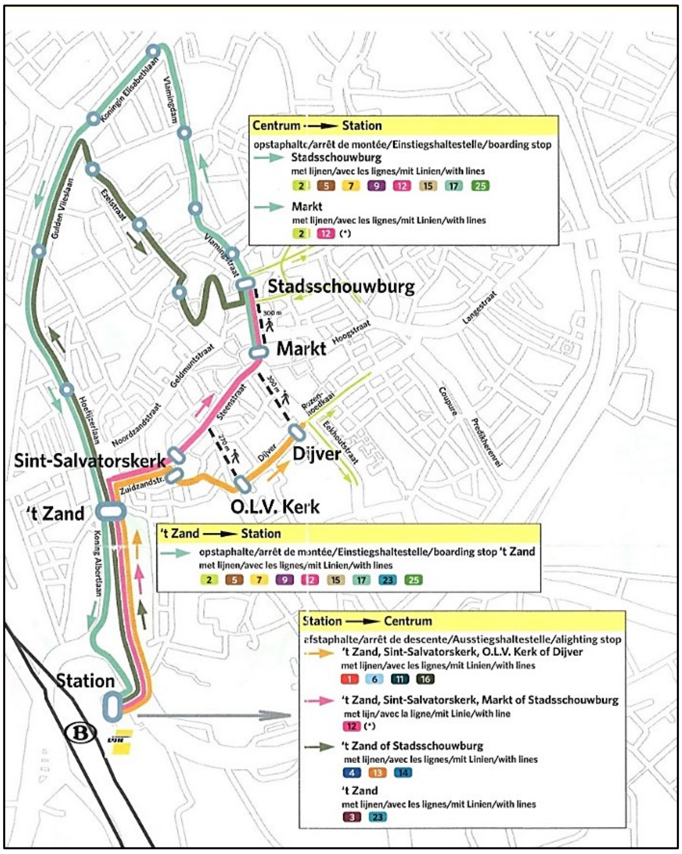

Figure 3.39: No presence of directional symbol/bar scale (Source: De Lijn Bruges Bus Map,2016)

In another case, Edinburgh's full schematic bus network maps did put a relatively small directional symbol on top of the legend column (Figure 3.40), but there is no scale bar on this map. The size and the remotely placing of this directional symbol place might hint about the importance of this directional symbol for the map purpose.

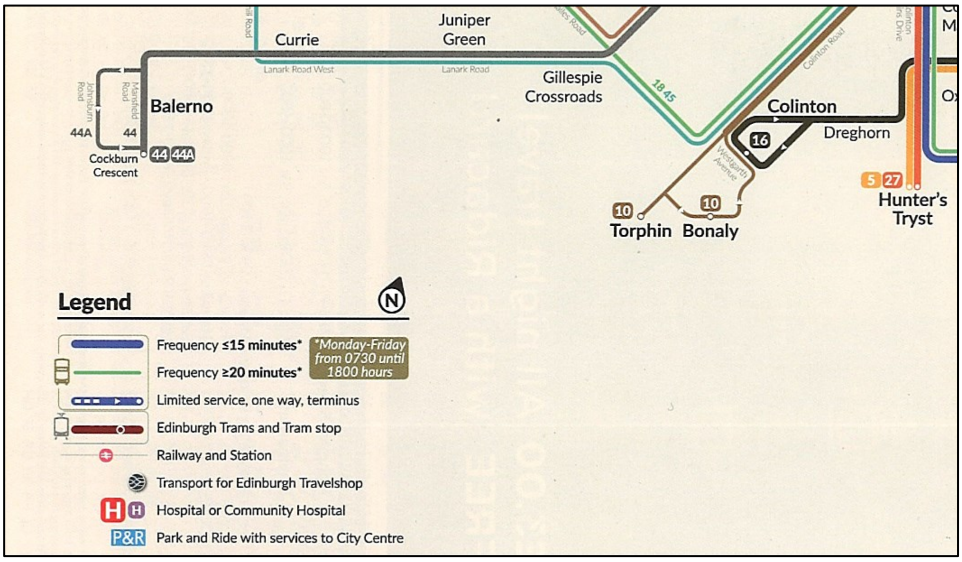

Figure 3.40: Presence of directional symbol in schematic bus map (Source: Edinburgh Route Map, 2016)

3.8.10 Inset Map Appearance

The inset map usage in the studied bus maps varied between the two types of bus maps. For Geographical Approach bus maps, 60% of the maps included an inset map, while only 32% of Schematic Approach bus maps have an inset map. This situation is understandable as there is a lack of need for further detailed inset maps to be included in schematic maps as scale varies to allow space to include important information in more crowded areas of the map.

An example is an inset map from the Chesterfield Bus Network map focusing on presenting more bus route information in the city centre (Figure 3.41). The main map and the inset applied different types of map design. In the inset map (Figure 3.42), there are no colour-coded bus route lines shown. The cartographer instead chooses to represent the bus routes with their numbers only but still retains the colour associate with each bus route line found in the main map. This inset map makes it possible for the map makers to include much more information, such as bus stop location, additional road network, scale bar, and critical points of interest. This inset map was placed on the map's reverse, so it is not the same page as the principal map. This location might bring a minor difficulty to the user as they need to link information between two pages of the map before they can comprehensively understand the information given by the inset map.

Figure 3.41: Presence of inset map in bus map (Source: Chesterfield Bus Network Map, 2009)

Figure 3.42: The inset map of the Chesterfield bus map (Source: Chesterfield Bus Network Map, 2009)

3.8.11 Landmark Appearance on Bus Map

For the Geographic Approach bus maps, especially Full-road network ones, landmarks are widely used. Eighty-five per cent of Geographical Approach maps include landmarks or information about key points of interest. As the Geographic Approach is firmly based on a topographic map, it is not surprising that a large amount of landmark information is also presented in this type of map.

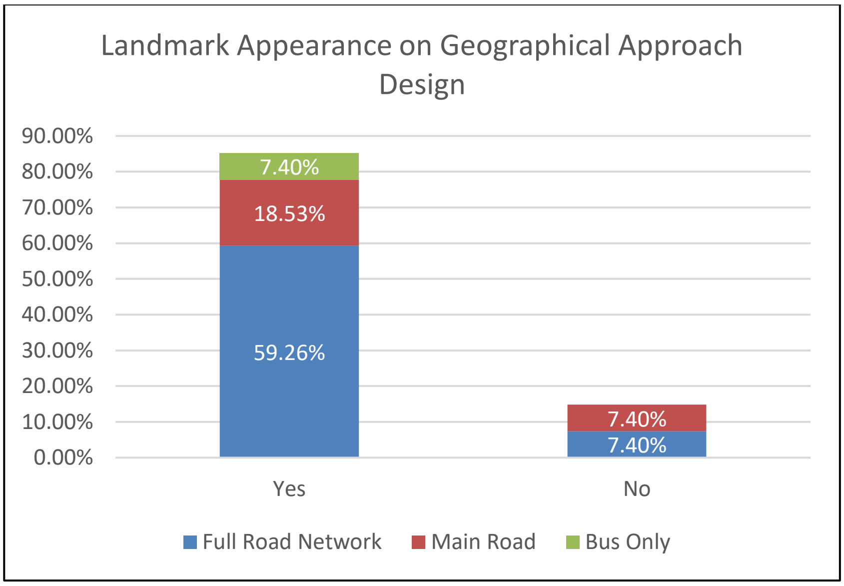

Figure 3.43: The landmark appearance on Geographical Approach bus map design

However, there are cases where a Full-road network bus map does not show any landmark symbolisation as shown in the ZTM Poznan Tram and Bus Map (Figure 3.44). Map users need to use the road name and other geographical features to start orientating themselves when using this kind of map. Some maps, however, do not use any symbolisation to represent the landmarks. As shown in Figure 3.45, a user needs to read the text to know the bus map's landmark. Symbolisation to represent landmarks would bring cognitive value to any map and ease using the map.

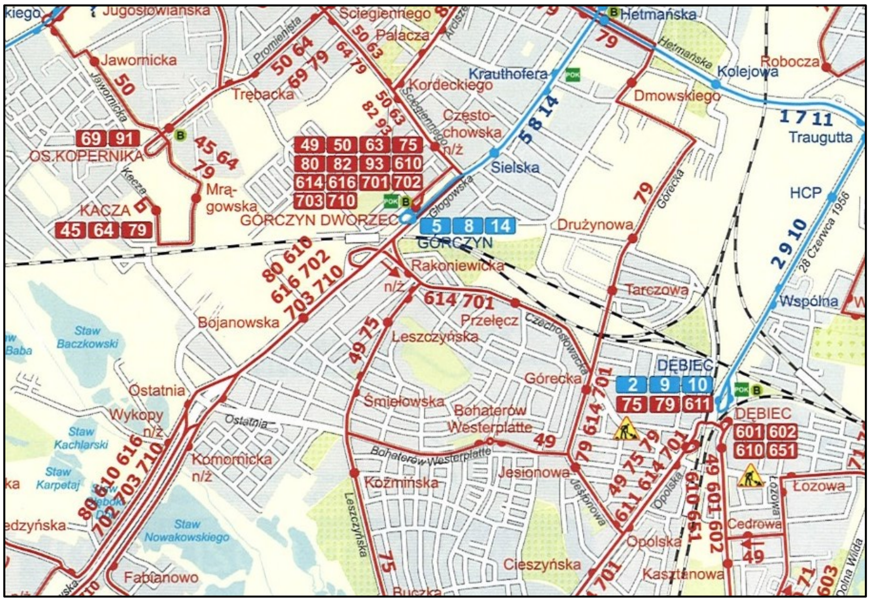

Figure 3.44: Lack of landmark symbolization in a bus map (Source: Map Network Connections ZTM Poznan, 2014)

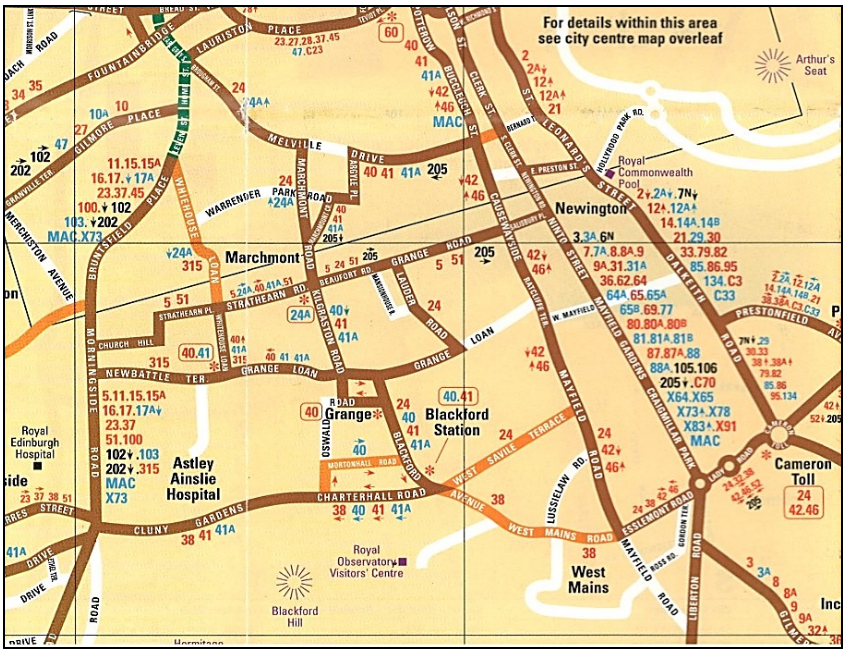

Figure 3.45: Minimal landmark symbolization in a bus map (Source: Edinburgh Travel Map, 2010)

As schematic maps tend to show only the bus route lines with few other features on the map, the number of the landmarks is minimal in this map format and is generally limited to extraordinary landmark features. The total percentage of Schematic maps that contain information about landmarks is 72%, slightly lower than the Geographical Approach design. Almost all semi-schematic maps did present the landmark information in their maps, whereas more than half of Full Schematic maps do not include any information about landmarks.

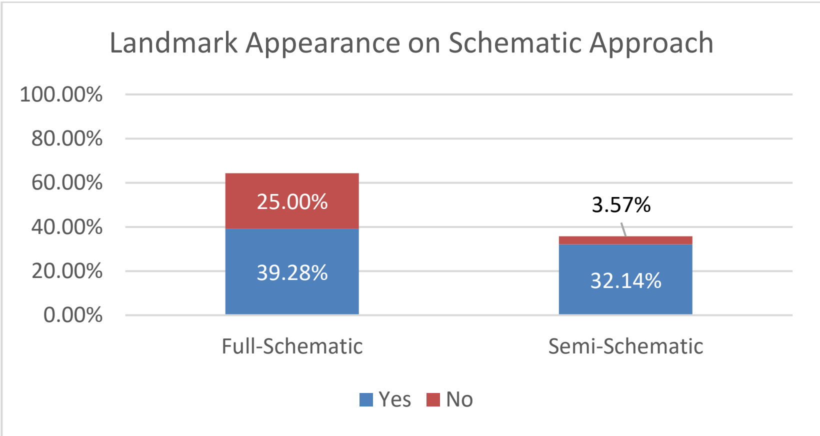

Figure 3.46: Landmark appearance on Schematic Approach bus map design

Although there are high numbers of schematic design maps that include landmarks, the number of landmarks presented is often limited. This situation can be seen from Dresden's bus map (Figure 3.47). There is only one landmark shown, which is located in the centre of the map.

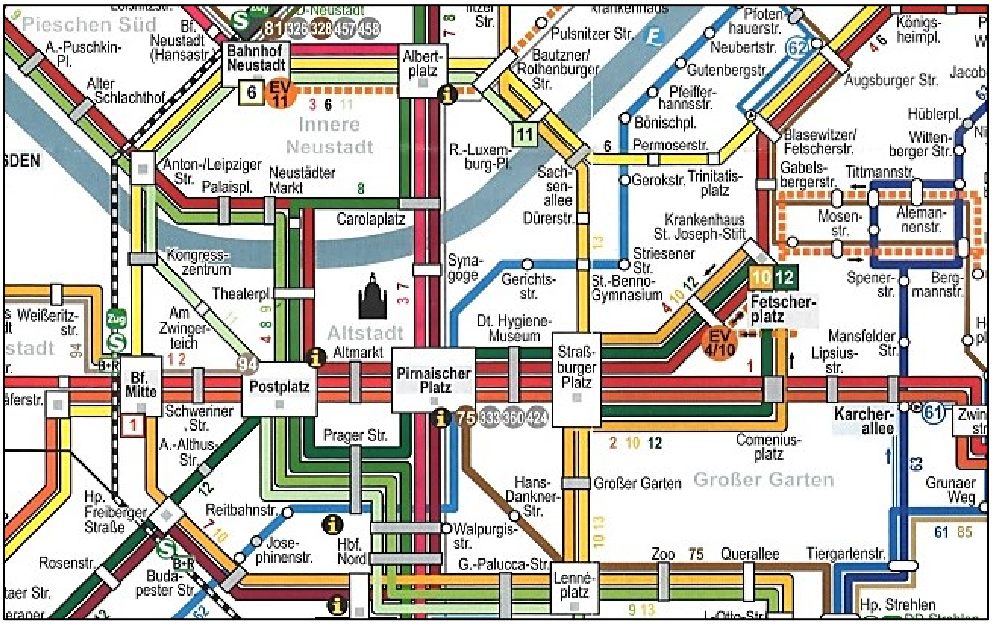

Figure 3.47: Lack of landmarks in a Schematic Approach bus map (Source: Liniennetz 2013)

Another example of the lack of landmarks can be seen in Figure 3.48. Here, there are only a few landmarks on this map, and the representation of the landmark is also not consistent. In this map, some of the landmarks are shown with a symbol. However, this presentation is not applied to all the landmarks shown on the map

Figure 3.48: Lack of consistency in the landmark's representation (Source: Byens Net Guide, 2011)

However, there are numerous good examples of landmark presentation in a full schematic design. One of the better maps is the full schematic bus route map from Central London (Figure 3.49). There are many landmarks presented on this map, and they are well distributed to every corner of the map. The excellent positioning and legibility of the landmark icons made the map easy to use and should not confuse the users while using the map.

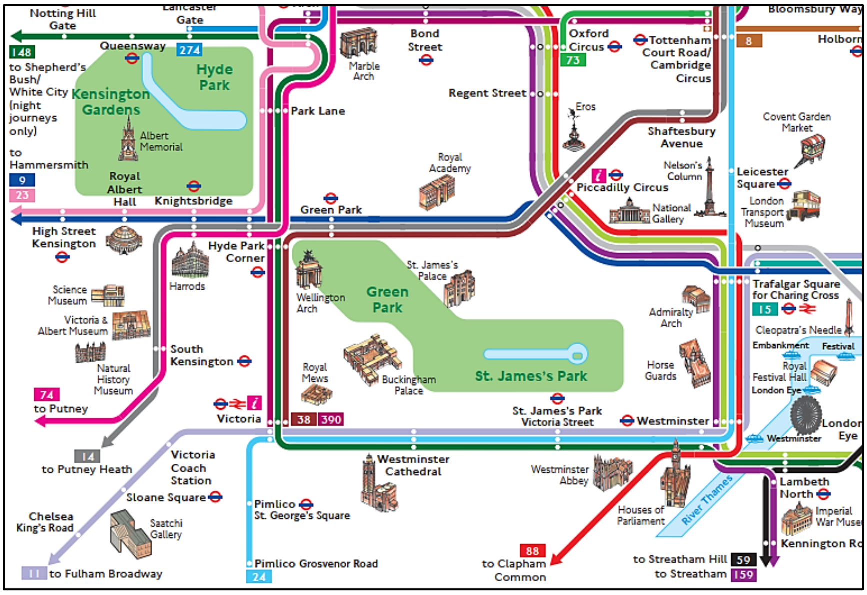

Figure 3.49: Bus route map of Central London (Source: Transport for London, 2018)

3.8.12 Type of Symbol Used to Represents Landmarks in Bus Map design

Based on the surveys, pictographic symbolisation dominates in bus maps with 66.67% of Geographical bus maps and more than half of Schematic bus maps using pictographic symbolization.

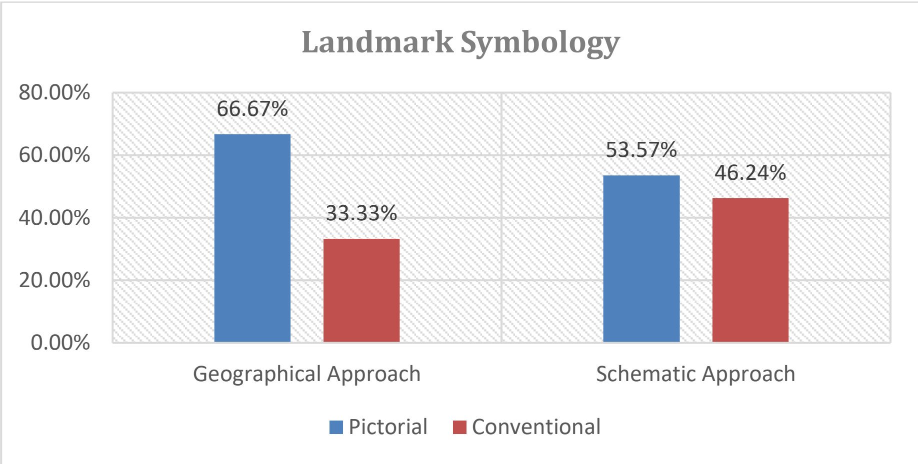

Figure 3.50: Type of landmark symbology used in bus map

The use of pictographic symbolization to represent landmarks can be exemplified by a transport map of Copenhagen, Denmark (Figure 3.51). The landmarks in this map are symbolized using icons that resemble the actual shape of the landmark that it represents. Using this type of symbolization, the map user does not need to rely much on a legend or other description associated with the landmarks label as they can understand what the icon represents through the symbol appearance. The usage of pictographic symbolization adds an aesthetically pleasant representation of information and brings a unique factor that differentiates one map from the rest.

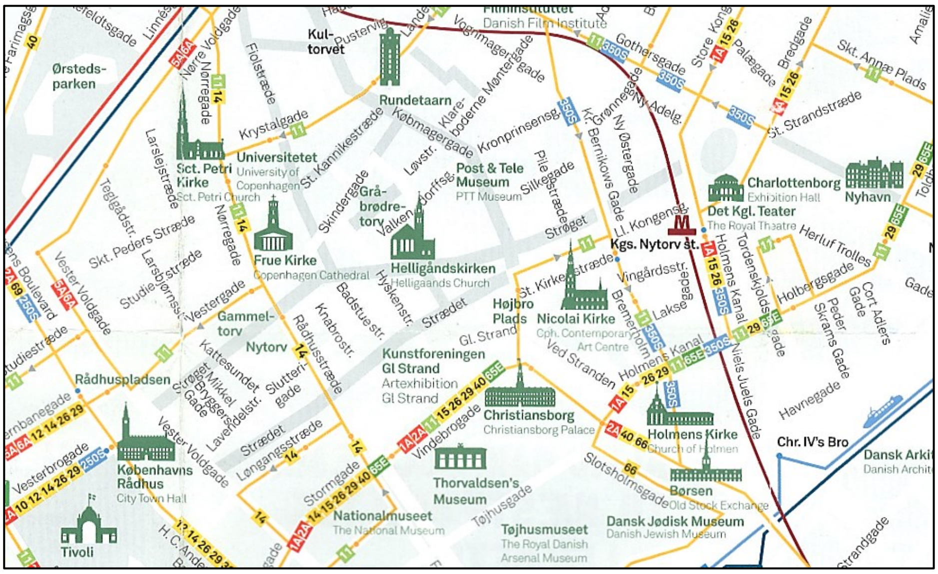

Figure 3.51: Pictographic landmark symbolization in Bus Map (Source: Byens Net Guide, 2011)

On the other hand, the use of conventional symbolization can be exemplified by a bus map from Southampton (Figure 3.52). There is a limited range of point symbols throughout the map, with individual landmarks identified by accompanying text.

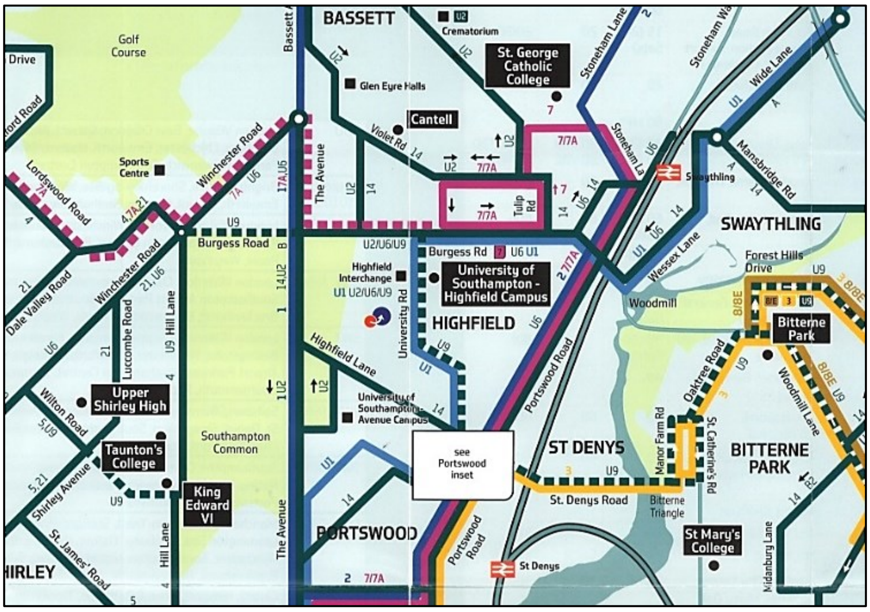

Figure 3.52: Conventional landmark symbolization in a bus map (Public Transport Map – Southampton City Council, 2010)

One interesting example of landmark symbolization can be found a Glasgow bus map (Figure 3.53). In this map, the landmarks are symbolized by using pictures placed at the landmark locations. The pictures vary in shape and size, depending on the nature of the landmark. This feature notably will enhance the user's understanding of the landmark information. However, it would be difficult to use this symbolization as space and complexity of information might be the barrier to place the pictures in many cases.

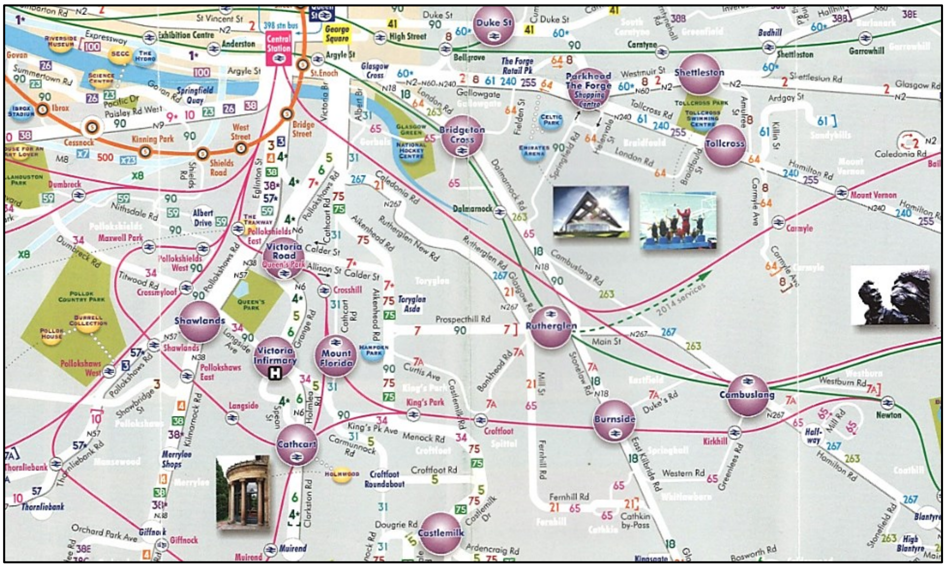

Figure 3.53: Unique landmark symbolization(Source: Quickmap All -On-One Map, 2013)

3.9 Summary of the Map Review Process

Analysing and classifying in detail the current and past cartographic approaches to bus map design is indeed a challenging process. This challenging situation is because there are a variety of different cartographic design and visualization techniques practised. Based on the map analysis carried out, there is no single stand-out design. Nevertheless, the resulting classification analysis outlines several consistent map design and map element criteria preferred by many of the map makers.

These findings will help identify what should be considered when designing a bus map in a specific context. This map review and analysis process are used together with several other public transport map design guidelines in designing prototype system maps. These prototype maps then underwent map usability testing with a focus group of current and potential public transport users. Table 3.3 below summarizes the findings of the bus map review and analysis.

This kind of map review analysis and subsequent guidelines should be done more frequently and extensively, especially around a stipulated time or before a new map will be produced. This measure can help find the right of balance in how much information we should place in public transport information publications.

Table 3.3: Summary of the key findings from the bus map review and analysis

Numbers	Map Design Criteria	Major Distinctive Element
1.	Map Design	1. Geographical Approach – Full-road Network / Main-road 2. Schematic Approach – Semi Schematic
2.	Map Size	Large size
3.	The visual variable is used to differentiate between the transport mode.	Combination of variables or Colour only
4.	Variable used to differentiate between bus route services.	Colour
5.	Variable used to during overlap situation	Maintain the current representation
6.	Level of Visual Hierarchy	Essential, to provide an excellent level of visual hierarchy
7.	Presence of grid	Non – essential
8.	Presence of waterbody	Essential

9.	Presence of directional symbol and bar scale	Non - essential
10.	Presence of Inset Map	Geographical Approach – Common Schematic Approach – Uncommon
11.	Presence of Landmark	Desirable
12.	Symbology for the Landmark	Pictorial symbolization in both map designs
13.	Symbology Explanation	Non – essential

Essential information must be included in the maps, followed by the minimal appearance of non-essential information, and other unrelated information about the journey planning process should not be included. This research will take the findings of this map review in creating and designing the new bus maps. The explanation of the research methodology used in this research are presented in the next chapter.

CHAPTER 4

Research Methodology and Test Location Suitability

4.1 Introduction

This chapter discusses the research methodology applied in this research. This methodology is drawn upon previous map use and map usability studies. The discussion includes an explanation of the methodology used in map user testing, the criteria involved in selecting the test location and the creation of user test materials.

4.2 Methodologies for Cartographic Map User Testing

There is no definitive guidance on conducting public transportation information use and usability tests. However, Robinson (1977) highlighted five main general approaches on how to conduct cartographic research. These approaches are summarised below.

1. An indirect approach – Empirical
   This type of approach is heavily reliant on the individual opinion of a cartographer. It is a trial and error method.

2. An indirect approach – Adaptation from studies in other fields
   This method essentially adopts methodologies and ideas from other areas related to the Cartographic discipline, such as methods on the psychological study of graphic design.

3. Direct approach – User reaction's census.
   This approach focuses on getting direct feedback from the respondent. It involves employing questionnaires and holding an interview. The objective is to determine which map design is the best design from a range of other related designs.

4. Direct approach – Task orientated
   This method involves an actual user test based on a specific map use task. The results depend on how well the respondents react to the tasks given.

5. Direct Approach – Psychophysical
   This approach comprises experimental user research. In the experiment, the researcher will investigate user reaction after they are presented with various visual stimuli.

In deciding what research approach is to be used, it is vital to determine the target map product's tasks and purpose. Every map has a specific objective and purpose. Before a detailed evaluation of maps can be produced, an appropriate map-reading task must be planned concerning the intended map reading objective. Connecting the crucial aspects of map purpose, map design, and map reading can help establish a meaningful standard for a map design (Board, 1978). It was decided to use the Direct Approach (task-orientated) as the primary methodological approach, as this approach is most likely to produce results that will impact to the intended map purpose.

The methodological approach was further developed around a theoretical research approach, namely User-Centred Design (UCD). In short, the UCD methodology defines how and why the needs of the map user needs to be considered or involved in the process of creating any mapping related product (Figure 4.1). UCD starts the process of product development and subsequent processes from the viewpoint of map users. The first stage of UCD is the business requirement enquiry, followed by a thorough analysis of the research requirement process in the second stage of the UCD. The last stage comprises the overall design system and product delivery. This philosophy is appropriate because the users purposely use maps and other map-related products. It is beneficial to include the map user's conception, development, and evaluation into the process of map design (Kramers, 2001).

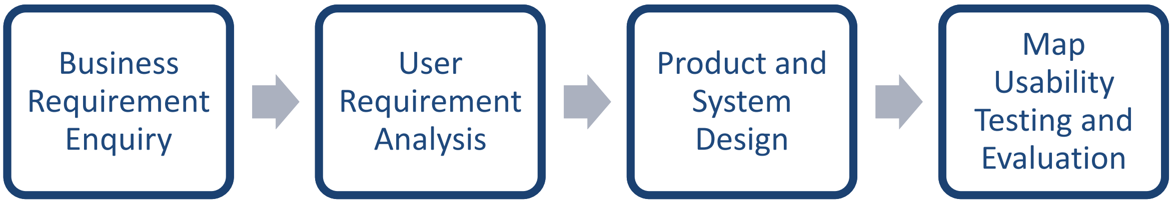

Figure 4.1: Theoretical framework of User-Centred Design Methodology

Often the mapmaker will have an indirect preference in the design and evaluation of their product. The mapmaker's previous experience, beliefs, and understanding of what they think is best for users can influence their decision-making process in developing and designing aspects of a product. To avoid this from happening, users need to be consulted directly to understand their actual perspective fully. As mentioned by Williams, O'Brien, & Kramers (2003), it is insufficient for the product developers and cartographers to only use their own experience and knowledge in determining what is best for users without taking substantial input from them. UCD reduces the risk associated with the lack of user understanding by eradicating unacceptable design and low functionality options. This process results in only one of the best outputs remaining. Moreover, understanding user needs will help create a map that effectively meets the user's requirements to complete a task.

From the theoretical framework, this study then defines the precise conceptual framework. This framework was then tested in a pilot study before being implemented during the final research data collection (map usability test). In general, the conceptual framework of the research has five stages. Implementing the research in five separate stages will ensure that all the processes reflected the user's needs. This conceptual framework of the research is described in the flowchart below (Figure 4.2).

Figure 4.2: Conceptual framework for the research

4.3 Selection Criteria for Research Area

The final map usability test area was selected based on the local socio-economic situation and the public transportation system currently being used in the location. Based on these criteria, any new or rapidly expanding large town or smaller city developing a public transport network is likely to be suited to whole-network mapping. In Malaysia, many areas could serve as potential test sites. The most significant benefits will be most likely a large town / smaller city rather than an established capital city or large city. Implementing a new concept of whole-network design will help improve the bus transportation system in that area and lead to a better urban development process as a whole (Campaign for Better Transport, 2015). In selecting the best research area, it is essential to consider the current socio-economic situation and public transport system in Malaysia.

4.3.1 Urbanisation in Malaysia

Urbanisation in Malaysia is expected to reach 75% by 2020 (Federal Department of Town and Country Planning, 2010). In the Second National Physical Plan, launched in 2010, full decentralisation has been chosen by the government as the prime strategy in the national physical development plan. In this plan, the physical development will be the focus on selected central urban conurbation areas.

There are four levels of conurbation growth areas in Malaysia. The first level of the conurbation area, known as national growth conurbation, it is followed by regional growth conurbation (second level), intermediate growth conurbation (third level), and future growth conurbation (fourth level). The selection of areas categorised in each conurbation level is based on the socio-economic situation and geospatial factors (population numbers and population densities, state geographical location). Table 4.1 shows the detail of the conurbation growth areas in Malaysia.

Table 4.1: Conurbation growth level and area in Malaysia

Conurbation Growth Level	City / Area	Population
National	1. Kuala Lumpur and Klang Valley Area	4.815 Million
Regional	2. George Town 3. Johor Bahru	1.266 Million 1.013 million
Intermediate	1. Ipoh 2. Kuantan 3. Kuala Terengganu 4. Kota Bharu 5. Alor Setar	536 832 317 000 255 518 251 801 252 900
Future (State / District)	1. Melaka 2. Batu Pahat 3. Kangar 4. Temerloh 5. Lumut	151 082 124 269 54 282 36 714 31 545

Source: (Department of Statistic Malaysia, 2017)

The numbers in the table above (Table 4.1) are based on the National Physical Plan 2010, published by the Federal Department of Town and Country Planning, Government of Malaysia. The Kuala Lumpur and Klang Valley area is the sole urban conurbation area that qualified to be placed in the first level cluster. The second cluster level includes the urban conurbation areas of George Town and Johor Bahru. All these conurbation areas have a population of more than 1 million people (Kuala Lumpur (4.8 million), George Town (1.26 million), and Johor Bahru (1.01 million)). These areas traditionally have been prioritised by the Government for physical and urban development. The priority is made mainly because this area is the highest populated region in Malaysia. It is predicted that Kuala Lumpur and the Klang Valley area will continue to be the main economic engines of Malaysia's growth, with strong support from the George Town and Johor Bharu conurbations. The geographical position of each conurbation areas can be seen in Figure 4.3.

Figure 4.3: The urban conurbation areas in Peninsular Malaysia (source: Federal Department of Town and Country Planning, 2010)

The Government has taken a pre-emptive action to avoid Kuala Lumpur, George Town, and Johor Bharu emerging as the only overwhelming primary cities. As shown in the National Physical Plan 2010, the Malaysian government has acknowledged emerging and increasing economic growth and development across Malaysia. The focus has turned toward the intermediate growth conurbation areas, led by the City of Kuantan.

4.3.2 Bus Transportation System in Malaysia

As mentioned in Chapter 1, the public transportation system in Malaysia covers various transportation modes such as bus services, taxis, and rail transportation. In terms of urban transportation, only Kuala Lumpur and Klang Valley areas have rail transportation (Mass Rapid Transit, Light Rail Transit, and Electric Train) as one of the urban public transport modes. Other urban areas in Malaysia depend on bus services and taxis. This highlights the importance of bus services as the primary mode of mass public transport in Malaysia. The discrepancy between public transportation services in Klang Valley with other urban areas has been a concern of many urban development enthusiast in Malaysia. There have been proposals to increase rail transportation, especially for cities categorised under the Regional Conurbation Growth area, but nothing has materialised.

Since 2010, the Government has taken serious action to revitalise the urban bus services in Malaysia. Through the Government Transformation Programmes (GTPs), every major city has seen new bus fleets introduced and new bus operating and management systems. The same type of operation and management process of bus transportation services is applied in each city, indicating that the same bus information system is needed. The list of cities involved in the GTP's initiative are listed below (Table 4.2). The number of urban bus routes is also shown. All the urban bus systems shown here are running under the same operating procedure and system management.

Table 4.2: List of urban bus routes in cities of Malaysia

No	Location	Number of Bus routes	Bus Provider Company
1	KL and Klang Valley	167	RapidKL
2	Johor Bahru	21	MyBAS (with Handal Indah)
3	Penang	23	RapidPenang
4	Kuantan	15	RapidKuantan
5	Kamunting	4	RapidKamunting
6	Manjung	3	RapidManjung
7	Ipoh	9	MyBAS (with Perak Transit)
8	Seremban	8	MyBAS (with City Liner)
9	Kangar	7	MyBas (with Mara Liner)
10	Kuala Terengganu	6	MyBAS (with City Liner)
11	Melaka	7	Panorama Melaka

Table 4.2 shows the contrasting number of urban bus routes between the bus services in the National / Regional Conurbation growth area and the Intermediate Conurbation growth areas. This contrasting category of the city should be taken into consideration in selecting the final research area.

4.3.3 Final Test Area Selection

It was essential to identify a research area that effectively encompassed both selection criteria to demonstrate the versatility of the whole-network bus maps produced. It was decided the research area should be chosen from the cities listed under the Intermediate Conurbation Growth area. Cities located in the National and Regional Conurbation Growth area have already benefitted from massive government investment in the public transport and transport information provision (National Land Public Transport Commission (SPAD), 2016b). The number of bus services also played a part in selecting the city.

From the group of Intermediate Conurbation Growth cities, the City of Kuantan was selected as the primary research area for this study (Figure 4.4). In terms of bus services provided in the area, this city has a modern bus transportation system based on the Government Transformation Programmes (GTPs) initiative. The Kuantan Conurbation received the new bus fleets and introduced the new bus management system in 2013 and was among the first areas implemented under the GTP's public transport initiative. The environment of the bus transportation system provided in this area is appropriate as a basis for the map usability testing process.

This choice is further enhanced because Kuantan Conurbation is the prime area targeted by the Government for the next process of urban development. The Government aimed to move Kuantan from the Intermediate Conurbation level to the Regional Conurbation level. The geographical position of the Kuantan Conurbation, located at the East Side of Malaysia's Peninsula, has made it possible for it to develop as the vital fulcrum for the economic spread effect in this region (Economic Planning Unit / Prime Minister's Department, 2015).

This city is located about 250km east of Kuala Lumpur. Kuantan Conurbation is one of few cities in Malaysia that has a container port (the main port for the east coast) and an international airport. Thus, the City of Kuantan is the largest developing city in the East Coast Corridor economic region (Azmi and Nor Fanim, 2012).

Figure 4.4: City of Kuantan's Location (source: Malaysia's Survey and Mapping Department, 2016)

The basic principle of sampling is that it is possible to obtain reasonably accurate findings without gathering data from every possible candidate (Denscombe, 2014). Thus, it is still feasible to conduct this research in a large town / new development city with similar characteristics to other cities so that the results and findings can be applied more widely. It is believed, due to Kuantan's dynamic urban development characteristic and applicable bus transportation system, the findings from the study done at the city of Kuantan can be replicated, not just for the city located in the intermediate growth group, but also for the cities that list in the regional conurbation growth group.

4.4 Designing and Testing the Whole-Network Bus Map

For this research's later phases, the User-Centred Design (UCD) theoretical concept will continue as the main conceptual framework to achieve the research objectives. The third phase of this study starts with the process of designing two new whole-network bus maps. Here, the findings from the early phases of the research prove vital. The map design selection is primarily based on the findings from the early phases of this study. A map usability test was then conducted using the maps produced.

4.4.1 Bus Map Design and Creation Process

The map review findings have highlighted the map concept, cartographic design variables, and attributes that need to be implemented on the newly design whole-network bus map — two bus maps with different design styles created during this phase. These bus maps are then tested with users from the chosen research area. The process of designing and creating the two bus maps was carried out using Inkscape™, which is an open-source drawing package. The use of open-source software helps remove the argument that cost prevents the adoption of key outcomes of the research (Meier, 2012)

4.4.2 Geospatial Data Sources

The primary information needed in designing the bus map is a comprehensive, detailed digital dataset that represents the national road network in the research area. A decision needs to be made to select the best digital data set available regarding the spatial resolution and the spatial content needed for a bus map. In Malaysia, there is no open access to the national digital dataset. The national digital dataset is only available to government agencies and other related parties. It was decided that this study would make use of an open-source digital map database freely available on the internet, OpenStreetMap (OSM).

OSM is a community-driven project (crowdsourcing), and while the quality and completeness can vary, in the study area, the dataset is diverse and comprehensive. Thus, this situation has made it very useful as the source for the base map design. OSM provides all critical information needed by a transportation map such as road networks, rail lines, water bodies, land use, and land cover areas. The large number of contributors contributing data to OSM every day helps keep the OSM data reliable, accurate, and up to date.

Information about the bus routes, bus stops, and other related information on the bus services in the research area was gathered from the primary bus provider in the area. The primary bus service provider in the research area is RapidKuantan (RK). Apart from downloading the online data, a visit was made on 17th August 2017 to RK's main office. The visit was very beneficial as the researcher managed to gather all the needed information.

The visit was conducted by Mrs Siti Aisyah Ismail, the IT Executive at RK. She covered introductions to all departments, including the advanced RK’s Bus Control Center. The Bus Control Center or BCC acts as the centre for all the bus fleet management and service information. This centre collect, store and visualize all the digital information for the whole bus operation. A further meeting with RK’s Head of Bus Operation, Mr Zamri

Mamat, was also arranged to solicit the view and perspectives from their senior management (Figure 4.5).

Figure 4.5: Meeting with RapidKuantan’s Head of Bus Operation

Despite the impressive bus information system, it was a surprise to find that the data made available to the public, especially bus route information, was minimal. A network map can only be found at the central bus terminal, and only lists of destination in the form of thermometer diagrams were in place at bus stops. All the bus routes and bus service information are available in hardcopy and softcopy form (printed form or display on their websites). No data comes in the form of a digital dataset or a GIS-ready data format.

Having acquired all the necessary information, the process of map generalisation and design were then performed once both data (base map and routes data) had been converted into appropriate digital format (shapefile). The lengthy process of acquiring and digitising all the related bus route information further highlighted this study's essential deliverables to enhance the bus map system around the research area and Malaysia more generally.

4.4.3 Map Usability Tasks

A map usability test was selected as the methodological tool used to complete this research's fourth phase. This map usability test is an exploratory approach to public transport map use and usability. In general, a usability test is a test that aims to identify any usability deficiencies and create an effective product (Rubin and Chisnell, 2008). In this test, the evaluation will focus on the product (maps) and not the participants. The participants will help to detect any flaws in the current design. The focus on using a prototype rather than the 'final' product is in line with the user-centred design principle.

The map usability test will gauge the response and performance of a participant in a testing scenario. The test is based on the user profiles, personas, and scenarios that have been established at the early stage. The participant's observation and the ability to complete the task will determine the success of this test. As discussed in Chapter 2 (Section 2.6), the test evaluation needs to be centred around three factors:

1. Effectiveness: The ability of users to complete the journey-planning task;
2. Ease of Use and Level of Confidence: User's self-rated evaluation based on the journey-planning task given;
3. Satisfaction: User's self- rated evaluation, given after the usability testing takes place.

The effectiveness evaluation is measured quantitatively based on six journey-planning tasks, with users required to complete three route-planning tasks in each map design style. The respondents need to plan a journey using bus service(s), which would take them from a start position to the given destination. There are three trip planning tasks for each subpart: one simple journey planning task, one medium difficulty journey planning task, and one complex journey planning task. This study provides one more trip planning task than in a previous study by Hardin, Tucker, & Callejas (2001).

The three tasks are different in terms of complexity. The first task is a simple trip, which means the trip requires only a single bus route (one bus per journey). The second is a medium complexity trip, which requires two different bus services, and the third task is a complex trip, which requires three or more bus services to complete the journey. The instruction was given for each task, which included the origin and the destination of a journey. Respondents were reminded that they must give the optimum route in completing each journey-planning task.

The ease of use and confidence level is measured after completing each journey-planning task. Likert scales were used to gauge the respondent's feedback on these criteria. Each respondent was asked to rate the ease of use and confidence level after using each map in completing the journey planning tasks. Next, the user satisfaction level was measured after they completed all six journey planning tasks and rated their ease of use and confidence level. Respondents were asked about which map design they feel more comfortable to use, which map they considered the most effective, and whether this kind of information can stimulate them to make more public transport use in the future. Respondents were also asked about their view on the number of landmarks and their inclusion on the map. Lastly, respondents were asked to give comments or any recommendation subjectively based on their general feelings after completing all the test procedures.

4.4.4 Test Location

Besides the theoretical consideration discussed in Chapter 2 (section 2.6.3), It is also essential to consider the cultural aspect in determining map user testing (Perkins, 2008). Based on the reconnaissance survey, the participants need to be selected with a pragmatic approach (early appointment), and a majority of them would like to participate only if the study was carried out in a closed space area. Conducting the research only in a real-world situation will make it harder to attract participants to complete the map user test, thus not achieving the required number of subjects in the available research time.

From all the points considered above, it was decided that the whole-network bus map test would be carried out primarily in a laboratory condition. The wider proper potential use and purpose of the whole-network's bus map would be for it to be used in both home/office environments (close space) in planning routes, and in public space during the navigation task; therefore, testing in both environments is desirable in the future.

4.4.5 Fictional Data Versus Real World Data of Bus Network System

The use of either fictional data or real-world data for the test maps is one of the research designs issues that needs to be addressed. This issue is not discussed widely and thoroughly in the map user/usability literature. The effect of the selection usually hinges on whether there is a need for users' previous knowledge of an area or if the user's familiarity can bring an adverse effect on the final findings and results.

The aspect of map user familiarity can be associated with cognitive psychology studies concerning map use. Cognitive effort is involved during the process of reading and understands the travel information. Consequently, familiarity with the location will reduce the level of cognitive effort needed in solving the route planning process (Grotenhuis, Wiegmans, and Rietveld, 2007). If fictional data were used, it would make it harder for the participant to complete the whole map usability test as they need to put more mental effort. This study is exploratory research, so every procedure needs to be focused on making it easier for participants to complete the test.

Furthermore, a significant part of this research investigates whether the whole-network bus map can successfully improve the current state of bus map design and development in the location. Using real data from the existing bus transportation system, responses can be compared directly with the current bus map situation. This condition certainly helps the respondents in answering several comparison-type questions efficiently. Once again, the usage of real-world data helps reduce cognitive effort. Using real-world data will also enable this research to test the unique local specification needs in map design, such as the number of landmarks, landmark types, symbolization, and colour variables to be used. The applicability of this study towards real-life situations will increase significantly with the usage of real-world data.

4.4.6 Ethical Compliance

An important issue when conducting human-involvement research is ethical considerations (Burton, 2000). Human capabilities and abilities were tested during a map usability test that required ethical approval. This research's methodological procedure does not have any apparent risk to respondents' physical or psychological well-being. There is, however, a slight probability that the respondent may feel uncomfortable with some aspects, topics, or tasks raised during the process of data collection. This situation might create unease amongst the respondents, but it is highly unlikely to create significant distress.

This research adheres to all the principals outlined in the Economic and Social Research Council (ESRC) framework of research ethics throughout the research process. The six fundamental principles are:

1. Research should aim to maximise the benefit for individuals and society and minimise risk and harm;
2. The rights and dignity of individuals and groups should be respected;
3. Wherever possible, participation should be voluntary and appropriately informed;
4. Research should be conducted with integrity and transparency;
5. Lines of responsibility and accountability should be clearly defined;
6. Independence of research should be maintained, and where conflicts of interest cannot be avoided, they should be made explicit.

Three main ethical issues were of concern before the test started. These ethical issues primarily focus on participant’s privacy, data confidentiality, and data security. Nevertheless, these three issues were swiftly clarified using the approach described below.

In eradicating issues around participant’s privacy, all participants were given a participant information sheet and the consent form. Their participation in this research will only be confirmed if they fully understand the information sheet and subsequently sign the form. The researcher has provided information about the study in a participant information sheet (Appendix B).

The participant Information sheet and subsequent consent form were given to the respondent once the target respondent verbally agreed to join the map usability test. Respondents were asked to read all the information given in the sheet before placed their signature on the consent form. It is crucial to make sure that the respondent fully understands why the research is being performed, the process and research procedure of the research, where the research takes place, and the assessor of the research. The information sheet also includes statements about information security and data confidentiality.

The researcher read the information sheet twice, once before the study and once after they finished the study. Participants were given a chance to ask anything after the researcher finished both the read-out sessions. The issue surrounding data confidentiality was solved by directly anonymising the data once collected. Each respondent was assigned a random ID, and the participant's personal data was keep separate from the response data. All respondent identity and personal information was kept entirely confidential. There was no need for personal information such as full name or address. Only necessary demographic information, such as age and gender, was requested. Participants have the option to withdraw their opinion from the study within a specific timescale. This approach makes it impossible to identify any participant in any published material and any data used for publication will be completely anonymised. Formal ethical approval was submitted to the College of Science and Engineering Ethics Committee before the pilot test was conducted. The committee gave full approval to the application. The certificate given by the committee concerning the ethical approval process can be found in Appendix A.

4.4.7 The Workflow of the Final Field-Testing Process

The final field-testing process was done in three parts. The first part is respondent screening and the preliminary assessment, followed by the journey planning tasks and, finally, a post-test assessment.

1. First Part: Respondent Screening

In this first part, a member of the public was greeted by the researcher. They were asked about their availability to participate in the research. If they agreed to participate in this research, they were asked about their preferred time and place to do the test. If willing, they were given a participant information sheet that summarizes the research and the test process. After they read and understood everything on the document, they were asked to sign a consent form before starting the test. After the consent form was signed, the respondents were given a self-completion questionnaire to start the preliminary assessment procedure. During this first part, respondents were asked about various demographic details and their current travel behaviour.

2. Second Part: The Journey-Planning Tasks

In the second part, respondents referred to the two newly created bus maps to complete the test (Geographical bus map design and Semi-Schematic bus map design). As previously mentioned, there are three journey-planning tasks for each map design format. Once the tasks were completed, respondents gave ratings on the ease of use and confidence level while using the map. Respondents only proceeded to the final section of the test if they completed all the tasks and the following question in the second part.

The research workflow in the second part of this final field-testing process is flexible, depending on the test's location. In the closed environment area (mainly at higher learning institutions across the research area), respondents will follow the standard test workflow, starting with the first part, then the second part, and the third part. However, due to the limited time window with each respondent at any public transportation hub, the test workflow was slightly altered for the open environment testing. After the respondent signed the consent form, they were asked to complete the journey planning task first before completing the other third and first part subsequently.

3. Third Part : Satisfaction Evaluation

Finally, the respondent was asked to fill out the questionnaire to evaluate their satisfaction level. There are five questions asked. The first two questions asked about their map preference in terms of easiness of map use and map effectiveness. The next two questions asked them to rate their likelihood of using the bus in the future should this kind of map be made widely available and rate their view about the map's landmark availability. Both questions were measured using Likert scales.

For the last question, they need to give any subjective feedback regarding the map design and map contents on the given blank space. Once every part was completed, the interviewer collected the forms and the research material. After the interviewer checked everything had been properly completed, the respondent was thanked for their effort and time.

4.5 Research Test Material and Test Instrument

Table 4.3 below summarises the research materials used during the final field test.

Table 4.3: Test material and test instruments

Test Materials	Test Instruments
1. Whole-network bus map (Geographical Approach design) 2. Whole-network bus map (Semi-schematic design)	1. Participant Information Sheet 2. Participant Consent Form 3. Questionnaire form, containing; Pre-test and post-test questions and Journey-planning tasks question

4.5.1 Test Material – The Whole-Network Bus Map

Bus maps are the integral research material in this study as the researcher seeks to find which bus map design is preferable and which map is more effective. The two bus maps created use the actual bus routes and bus information from the chosen research area. The two new whole-network bus maps created the use of different approaches. The designs are in the form of Geographical bus map design and Semi-schematized bus map design. The distinguishing aspect of these two bus maps is only in their overall map design approaches. Both maps share identical bus routes and other bus information detail, including every cartographic representation's aspect involved in the map, such as symbolisation, typography, and type classification. As mentioned before, these cartographical representation aspects and design variables of these newly designed whole-network bus maps were selected based on the results and findings from the map review process and related literature reviews. The map design process is discussed in Chapter 5.

4.5.2 Questionnaire Design

The questionnaire form was created to complement the journey planning task for this map usability test. A careful and critical approach has been taken into consideration while creating the form. According to Murray (1999), the questionnaire's final draft should be easy to administer, ethically obtain the required information, and not create any confusion or embarrassment when the respondents answer. It should not take a long time for the respondent to complete.

Scott, Hoinville, and Jowell (1978) stated that the questionnaire should be designed according to these four criteria:

1. Easy to conduct,
2. Ethically-correct in gathering the required information
3. Allow respondent to answer without any confusion or fear of humiliation
4. Require only a minimal amount of time and effort for the respondent to complete.

As the journey planning tasks make up most of the test, and since this is exploratory research, no time frame has been given to respondents to complete it. This openness will avoid any uneasiness and embarrassment for both respondent and the interviewers. However, since this study was partly conducted in the public transportation hub environment, it was essential to provide a questionnaire form that can be completed as quickly as possible while maintaining efficient structure so that the overall testing will gather enough data for data analysis (Evans, 2010).

A key factor to consider during the process of making a questionnaire is the length of the questionnaire. A long list of questions can frustrate any willing respondent (Burton, 2000). Research by the National Academies of Sciences Engineering and Medicines (2005) found a negative correlation between the given response and the length of the questionnaire. Furthermore, a survey in Denmark discovered that the interview completion rate was increased by twenty-five per cent when they pre-announced (before the survey starts) the whole interview process will take a shorter time (Hansen, 2007). These findings parallel the researcher's previous experiences during surveying where people quickly turn down any chance to be interviewed after seeing the large size of the questionnaire document. It is not useful for participants to start the process then withdraw due to the length of time needed to complete it.

The time factor was a major influence on questionnaire design. It is essential not to ask question that are too basic or ask for too much information in one question (Burton, 2000; National Academies of Sciences Engineering and Medicines, 2005; Knottnerus and Tugwell, 2010). All questions were expressed in an objective form. Respondents need to tick or circle their selection from a list of possible answers. Questions related to demographic factors such as gender, car ownership, and driving license availability only require selection from two options (yes/no, male/female), but the respondent may choose not to answer. Likert scales are employed to measure users' views on more complex questions such as bus use frequency, the confidence level, and the ease of map use rating. A maximum of 5 categories was used in each Likert scale-based question.

It was expected that the only problem respondents may have in completing the questionnaire might be the journey planning tasks. To avoid any biased results, the interviewer should not interfere during the journey planning tasks, which means no assistance can be given to the respondent even when the they seem to struggle with the task. However, if the respondent continues to struggle, this situation might put off the respondent's interest in answering the other questions and completing further tasks, resulting in early termination from the test. A 'Do not Know' option was provided in each journey-planning task answer space to avoid this situation. Respondents were briefed on this before the test to make sure they were aware of this option.

4.5.3 Questionnaire Form for Map Usability Test

Apart from the above considerations, it is crucial to incorporate three main usability factors in the test design. The factors are the effectiveness evaluation; the ease of use and level of confidence evaluation; and the satisfaction evaluation (Geisen and Bergstrom, 2017b). The user questionnaires are divided into three sections (Section A, B and C) to incorporate these criteria.

Section A solicited information about the demographic background of the respondent. In this section, seven questions were asked relating to the respondent's age, gender, accessibility to a car, driving license availability, experience and frequency of the previous bus use, and experience using other modes of public transportation. All the questions were objectively asked as the users are only needed to select their answer from the selection of answers given. Most of the questions only require straightforward Yes or No answers.

Section B comprises the effectiveness evaluation segment; and the ease of use and level of confidence evaluation. In this section, users need to complete three route-planning tasks in each map design format, with each route planning task represent a different difficulty level of journey planning task – simple, medium, and complex bus journey. Users are required to use only the information given on the two whole-network bus maps to identify the origin, the destination, and subsequently find the necessary route or routes to complete all the journey planning tasks. All the origins and destinations are marked on both maps. Every intended location is also written in bold letters in the questionnaire form to avoid user confusion during the test.

The locations selected to be used as the origins and destinations were carefully selected. Based on research by Hardin, Tucker, and Callejas (2001), it is unsatisfactory to use obscure locations that most respondents might not know, particularly for those who do not use public transport frequently and have little knowledge about the local geography. Hence, it was decided to select only popular locations (well-known, tourist attractions) around the mapping area as this would enhance the user's ability to complete the journey planning tasks. The locations selected were also well-dispersed around the map.

The table below (Table 4.4) describes the actual questions asked in each map journey planning task with its corresponding difficulty level. The locations for the origin and destination are written in bold letters.

Table 4.4: The questions involved in the journey planning tasks

Difficulty Level	**Map 1**	**Map 2**
Simple	If you want to go from **Kubang Buaya** to **UTC Kuantan**, what bus route or routes number will you use?	What bus route/routes number will you use if you want to go from **Galing** to **Taman Gelora**?
Medium	What bus route/routes number will you use if you want to go from **Perumahan Semambu** to **Permatang Badak**?	If you want to go from **Indera Mahkota 3** to **Padang MPK 1**, what bus route or routes number will you use?
Complex	You want to go to **Bukit Setongkol** from **Taman Indera Sempurna**. After you have arrived at **Bukit Setongkol**, you need to complete your journey to **Medan Tok Sira**. Please state the bus route/routes number that you will use to complete this journey?	You want to go to **Terminal Kuantan Sentral** from **Teluk Cempedak**. After you have arrived at **Terminal Kuantan Sentral**, you need to complete your journey to **Taman Guru**. Please state the bus route/routes number that you will use to complete this journey?

After respondents completed all the journey-planning tasks, they were asked to rate the ease of using the maps and their confidence level. The user’s feedback for this second map usability evaluation was categorised into a 5-points Likert scale. For the ease of use, the respondent was asked whether all the routes are easy to find, and they were instructed to give their answer within the five options given – from strongly disagree to agree strongly. Similarly, they were asked how confident they were in identifying the optimum service by using the maps provided for the confidence level rating, and they needed to rank this between not at all confident to very confident.

To conclude the test, users needed to complete the last section in the questionnaire form, which measured the respondent’s satisfaction level. In this section, the respondent was asked about their map design preference between the map designs tested. The respondent was also queried about their future bus usage should such maps be made widely available. They were subsequently instructed to rate their view regarding the number of landmarks provided on the map. A five-point Likert scale was deployed to gauge the respondent’s view of both questions. Lastly, a subjective question was given, which asked the respondent to give any comments or recommendations about the whole test process. A copy of the participant questionnaire form is included in Appendix B.

4.5.4 Software and Equipment

This study uses open-source software for the map design and map creation process due to the software's dynamism and robustness. Using open-source software goes beyond the financial benefit, and strong technical support is available due to its large, passionate user community. The geospatial aspects were done using Quantum GIS or QGIS™ (instead of ArcGIS™), and the vector graphic works were completed using Inkscape™ (instead of CorelDraw™ or Adobe Photoshop™). With these actions, it is hoped that it can further spur the use of open-source software in geospatial-related industry and academia.

As for the other equipment, a geo-tagged camera was used to take pictures of bus infrastructure and related bus service information. The camera was also used for other research purposes, such as capturing the fieldwork process (with the respondent's consent). A sound recorder recorded verbal answers from the respondent (at the public transportation hub/bus station). All audios and pictures were taken and recorded only with the respondent's permission and are saved securely in password-required physical hard disk and cloud storage.

4.6 Research Sampling

There are two types of experimental research study: the between-subject design and the within-subject design (Hardin, Tucker and Callejas, 2001). This study adopted the within-subject design as one of the objectives of this study is to find which type of map is preferable. A respondent needs to use both maps before they can decide which map design is preferable. In this within-subject research design, the respondents will complete journey-planning tasks using the two map design variants. To avoid any bias, half of the respondents will start the test using the Geographical bus map design, and the other half will start the test using the Semi-Schematic bus map design. This procedure will neutralize any biased on the final variant scores by eliminating the advantage of the cognitive learning effect, which the respondent would gain from their first journey-planning test. Using this type of experimental design, it is critical that both the maps have equivalent map elements (landmarks, road networks, typography) and the same instructions.

4.6.1 Sample Profile

Once the research area has been determined, it is essential to consider the sampling frame and sampling profile. This study will adopt a purposive sampling technique. It is essential to consider the general bus user profile in Malaysia as one criterion for creating a purposive sample profile. Sampling that can provide a similar demographic profile like the general bus user profile in Malaysia will provide a much more effective result. In achieving this sampling procedure, knowledge of the local demographic background is needed in developing the sampling process. Ponrahono, Bachok, Ibrahim, & Mohamed (2015) conducted a study to identify the public bus passengers' demographic characteristics across Peninsular Malaysia. As there are no official statistics on the demographic background of bus users in Malaysia, this study will use their findings on the demographics background of urban bus users based on the respondent's sampling frame.

According to the study, the dominant age group that uses urban bus services is those 24 years old and below. 47.78% of urban bus users come from this age group, which includes college and school students. A further 42.30% of bus user comes from the age group between 25-54 years old, which can be considered the working-age group. The remaining bus users come from 55 years old and above, with only 9.92%. Age 55 and above are considered as retirement age in Malaysia. In terms of gender, 64% of users are female compared to 36% male.

Based on the above information, most bus users in Malaysia come from the student group. As such, a test location will be focused on higher education institutions. The test was done at various public places across the research area, especially at bus service infrastructure locations - bus stops and bus terminals - to gather feedback from other bus users with diverse backgrounds. The minimum age for participation in this study is 18 years old, but no maximum age has been placed. There will be no children involved in this study. The researcher targeted respondents around the age of 18 to 24 years old, as this will reflect the major age range of bus users in Malaysia. However, this does not mean that the people in other age ranges are prevented from participating in the study.

Kuantan has a diverse range of higher education institutions. These institutions' geographic location is not centralised in only one area but is spread across the city, which will provide useful variation in the sampling profile. The participants will be purposefully selected so that breadth and depth of perspectives across different work contexts, experience levels, gender, and geographic locations are maintained. All respondents' views and responses will be treated as equally significant to each other by the researcher.

4.6.2 Sample Size

In a map usability study, it is important to have an appropriate sample size so that the research results will be relevant and usable. Based on the concept of usability studies as proposed by Nivala, Brewster & Sarjakoski (2011), only a small number of respondents may be required to make sure the sample is adequate to complete the study. However, a large sample of respondents will be preferable, as this will ensure the overall representation of bus users in the research area. According to Faulkner (2003), the minimum sample size for a usability test is 20 subjects for each product variant, which brings the minimum numbers needed for this map usability test to 40 subjects.

However, for robust statistical analysis of the findings, other techniques for determining the sample sizes were needed. In general, three main factors need to be considered when determining the sample's size needed for a survey. These the confidence level, confidence interval or margin of error, and use population size. The confidence level indicates how confident a researcher can be with the findings of a survey. On the other hand, the confidence interval ranges around a survey result that shows the statistical probability of other results matching the outcome. A smaller sample size typically means a lower confidence level. The user population size is the total number of peoples in the proposed research area (Kramers, 2001).

This study has carefully designed the sample size based on the three factors and based on this research's nature. This research is the first time such an empirical study on bus maps usage has been done in the research area. Although many studies on the public transportation sector have been done in the area, there was no study specifically on bus map usability (Chiu Chuen, Karim and Yusoff, 2014; Hamzah, Ayub and Hilmi, 2015; Borhan *et al.*, 2017). The total population in the City of Kuantan is 366 000 (Department of Statistic Malaysia, 2017). As this study is exploratory research, the margin of error has been set at 10%, as this percentage is deemed perfectly acceptable for this kind of research (Conroy, 2015). With the confidence level at 95%, this study's target sample size is set at 96 subjects.

4.6.1 Statistical Techniques Used

The map usability test gathered several results, ranging from the respondent performance based on the correctness of an answer to their opinions about the maps (ease of use of the map, confidence in using the map, and their map preference).

For the nominal data, the analysis was done directly using descriptive statistics. For the categorical data, the analysis was completed using non-parametric statistical analysis. The data collected for this study come from independent observations and are deemed not to be continuous, which is matched with the general assumptions outlined for the use of non-parametric statistical techniques (Pallant, 2016). Likert scales have been used to gather the information for several dependent variables. The most suitable way to analyse Likert scale data is using non-parametric procedures such as the chi-square test, Mann-Whitney U Test, or Kruskal- Wallis Test (Allen & Seamen, 2007).

4.7 Conclusion

This chapter describes the overall research methodology applied in this research. In general, the research process was divided into five phases. The first two phases were to define the research requirement and user requirement analysis, which were done through a detailed literature review and extensive map review on the current cartographic techniques and representations used in bus maps. In the later phases, the research focuses on designing a new whole-network bus map and subsequently test the map. This process includes explaining the sources of geospatial data used to create the map, discussing critical issues in map user testing, and the description of the test material and test instruments involved during the map testing.

The criteria involved in the research area selection were also discussed. Kuantan City, which is one of the major cities in Malaysia, has been selected as the research area due to its viability in terms of the local socio-economic situation and the current public transportation system used in the area. This chapter concluded with the clarification of the research sampling technique adopted by this research. The next chapter details the process of designing the test maps and presents findings from the user testing phase of this study.

CHAPTER 5

Designing the Whole-network Bus Maps and Conducting Map Usability Test

5.1 Introduction

This chapter describes the process of designing the prototype whole-network bus maps and performing the subsequent map usability test. All the essential cartographic elements selected in creating the map prototypes are justified, including the selection of colours and other visual variables, typography and map composition. Then, this chapter discusses the process of user testing for the newly-created whole-network bus map prototypes, starting with the pilot test.

5.2 Design of a Whole-network Bus Map

When creating a map, the cartographer's primary focus should be on the efficiency of its subsequent use (DeLucia, 1979). DeLucia further acknowledges that this task is not easy as extra effort is needed to create a map that is pleasant to the eye as well as being functional. As mentioned in Chapter 3, a few map design guidelines have been developed to help cartographers to create a better full network bus map. Besides the listed guidelines, this study acknowledges the importance of understanding the current cartographic representation variations used in bus maps. The findings from the map review process (Chapter 3) were the prime reference in designing new whole-network bus maps and were used together with the design guidelines.

5.2.1 Map Design Approach to Be Used

After the primary map purpose has been determined, the next step to be addressed when designing a map is to choose the general map design style. There are three map design formats for full network bus maps: Geographical Approach, Semi- Schematic, and Full-Schematic. Based on the map review, the most popular bus map design style is the Geographical Approach bus map design, followed by Full-Schematic and Semi-Schematic bus map design. After careful consideration, it was decided that it would be appropriate to comparatively test a Geographical Approach’s full-network map and a Semi-schematic map of the same location. This careful consideration includes the critical thought given by Morrison (1996), who stated that fully-schematic maps are not suitable for bus map use. The Semi-Schematic style is suitable as the design still adopts the parallel value of geographical location (even if significantly generalised) and does not use the extreme level of simplification and locational distortion typically used in Full-Schematic designs.

5.2.2 Map Dimension

The second specification that needs to be defined is the paper's dimensions to portray the whole bus network. The map review highlighted the various physical dimension of printed bus maps. Understandably, presenting a large amount of information is often more manageable with a larger paper size than a small one due to the advantage of space available. However, the largest available physical paper dimension is not an automatic selection. Consideration of other factors such as the map contents, the publishing location, the printing cost, and the mobility factor need to be taken into account

In terms of the map contents, it was decided that the new whole-network map will only show the bus service routes together with other major road information and important landmarks. The dimension chosen must be adequate to show all this information clearly. For the map publishing location, the aim is to display the map on information panels located at the bus stop/bus terminals. This means that the information panel's size at the bus stop must be considered during the decision-making process. The paper's size should maximise the size of the information panel to benefit the space provided fully.

The map review analysis suggested that the map should be published in a large dimension paper size (A3 or larger). It was determined that the largest paper size suitable for the information panels at the bus stops in the research area is A2 size. A further survey on the printing costs found out that the A2 size paper printing is economically priced due availability of advance printing services around the research area. Based on the above information, it was decided that the dimensions of the paper used in this study would be 42.0 cm x 59.4 cm (A2 Size). Both map designs will be presented in the same size of paper to eliminate any bias factor. A large size map cannot be seen as a hurdle to the mobility factor as the map can be folded, and A2 is not an unwieldy size when unfolded.

5.2.3 Background Colours

As for the map background colour, it was decided to use a multi-colour background. Generalised land cover classes will be represented in different colours. Using a multi-coloured background also brings another advantage as this type of background enabled the cartographer to show different types of land cover without the need for additional text or symbols. It is believed this can improve the map's usability, as many users will be aware of the pattern of built-up and open areas, and it was established in the map review that people expect major water bodies to be included, even in schematic maps.

However, the number of land cover types will be minimized to reduce conflict with the colour used to represent more prominent map features. Three major land cover classes were presented in the maps which are the built-up area (commercial and residential), the vegetation area (agricultural, recreational and park), and waterbodies (sea and river). Conventional colours were used for these classes, with built-up areas are shown in a red colour, vegetation areas shown in a green colour, and the water bodies shown in blue. To allow good contrast with the route information, light, low saturation versions of these colours were used for the land cover classes.

This colour scheme, or hue, is the most fundamental component of the colour. There are many colour variations under one colour scheme. These colour variations are made possible by introducing the other main components of colours, which is saturation and value. Value, or contrast, is the quantity of black or white applied in colour. Variations in the quantity of value for a given colour scheme resulting in fluctuating degrees of darkness or lightness for that colour. On the other hand, Saturation depicts the concentration of colour. Full saturation produces pure colours, while low saturation applied more grey elements to the colours. The diversities in saturation brings different shades and tints to the main colour scheme.

5.2.4 Define the Extent and the Alignment of Data

Kuantan is located on the east coast of peninsular Malaysia, sitting on Kuantan riverbanks and near the South China Sea. In 2017 there was a total 15 bus routes operated by RapidKuantan. These routes cover the Kuantan City Centre Area and few neighbouring towns in other districts. In order to limit the area covered and produce the map at an appropriate scale it was decided to eliminate routes extending beyond Kuantan City and focus on those which start and end within the city area.

As shown in Table 5.1, there are seven bus routes operated around Kuantan City Centre. The bus routes numbers and journey names are as indicated in Table 5.1.

Table 5.1: Bus service numbers and bus routes location in Kuantan City Center

Service Numbers	Bus Routes
Route 101	Hentian Bandar to Indera Sempurna
Route 102	Hentian Bandar to Permatang Badak
Route 200	Hentian Bandar to Teluk Cempedak
Route 201	Hentian Bandar to Taman Gelora

Route 302	Hentian Bandar to Indera Mahkota 2
Route 303	Hentian Bandar to Terminal Sentral Kuantan
Route 601	Hentian Bandar to Polisas Semambu

All the bus routes start their journey from the same bus terminal located in the heart of the City of Kuantan, before being dispersed to seven different termini. The routes are varied in distance, with the longest bus route stretched out to 25km from the city centre. The termini locations are well-scattered around the city, which makes it challenging to fit them all into one single map frame. The process of fitting the entire geographical area into one map frame was made using the QGIS™ software, with the route network data provided by OpenStreetMap™.

Figure 5.1: The extent of the area to be mapped (Source: OpenStreetMap, 2016)

Following several trial layouts in QGIS, it was decided the map would be presented in landscape form. The horizontal map frame has enabled the area to maintain its true north orientation, with north at the top of the map.

For the Geographical Approach bus map design, as the map will be on a fixed scale, due to network information density in the city centre, one inset map is needed to represent the chosen location at a much larger scale. The horizontal orientation enables the inset map to be included within main map frame instead of displaying it on another page. The sea area allows appropriate space for placing the inset map, the legend, and other map elements. The inset map is shown in the same orientation as the main map, thus reducing any confusion when users try to link up the information from the main map with the inset map. The spatial information located within the map frame was exported to Inkscape™ software for the map design process.

5.2.5 Selection of Colours Used to Represent Bus Service Routes

Colour is an important aspect in public transport map design as colour brings significant assistance in locating and differentiating elements on the map, especially if many other elements are included (Higgins et al., 1999). The colours selected for the route coding should be clear and concise, making them easily distinguishable from other map elements. Guidelines suggest that a bus service in a public transport system use the same colour scheme throughout the transport information system. For example, if a colour has been selected to represent a bus service in a network map, the same colour should represent the particular bus service in the timetable sheets, the directional signage, the vehicle colour and all promotional material related to the bus service. The consistent use of the same colour scheme can help create a bus route identity in every user's mind, which can subsequently lead to an increase in the map use effectiveness (Denmark, 2000; Scrimgeour and Forrest, 2008).

There is a maximum of only nine hues that can be easily differentiated when the colour is being represented by relatively narrow lines (Morrison, 1996b). Extra precautions in selecting colour are needed if there are multiple modes or more than nine routes involved in one map. In this case, it is advisable to combine the routes into several groups. The optimum colours recommended are yellow, green, red, brown, orange, blue, black, purple, and magenta (Cain et al., 2008a; Morrison, 1996b; Peterson, 2014).

For this study, there is only one mode of public transportation in the research area: bus services. There are seven different bus routes, and each route was represented in a different colour. There will be no services that share a similar colour. During the colour assignment process, the colour used to represent specific bus routes in a previous public transport map was considered. As mentioned, this step can reduce any confusing effect during the journey-planning test, where the previous colour used on other information material might have developed as the route identity in the user's mind, especially for the frequent user. The table below (Table 5.2) shows the colour used to represent the seven bus services.

Table 5.2: Colour used in representing bus services

Service Number	Colour (Hue, Lightness, Saturation,)	Colour Visual
Route 101	Yellow (35, 58%, 95%,)	
Route 102	Green (120, 31%, 78%)	
Route 200	Brown (0, 41%, 59%)	
Route 201	Light Purple (304, 84%, 86%)	
Route 302	Purple (295, 53%, 46%)	
Route 303	Blue (220, 59%, 89%)	
Route 601	Red (0, 50%, 100%)	

5.2.6 Visual Variable Uses in Representing Shared Service Route

Representing service routes on the same road is one of the challenging processes while creating a transportation map. It is impossible to avoid this, especially in the prime location of an area (e.g., the city centre). The Semi-schematic map uses the same representation in the city centre and the suburban area (colour lines). In the case of multiple services sharing a road, parallel lines were created adjacent to each other to represent all services on the same road. The default line width of 0.5mm was chosen to represent all the bus services.

The same representation method was applied in the suburban areas on the Geographical Approach map. However, another technique needs to be adopted when displaying bus services routes in the city centre area on the Geographical Approach bus map. Even with the increased scale of the inset map, it is impossible to continue to use the same thickness of colour lines to represent all the bus services. The city centre area is an area that contains an abundance of critical geographical reference information (such as a landmark, main attractions, major roads, etc.), which must be included in the map. Keeping seven parallel lines adjacent to each other on some roads will leave little space to present other important information and make it impossible for the cartographer to maintain map readability in the area.

The findings from the map review suggest two solutions to this problem: use thinner lines in congested areas replace the route lines with route numbers placed on or adjacent to the road. It was decided to represent bus services in the city centre area by route numbers. All the bus route roads will have the bus service numbers written beside it. The numbers are represented in the same colour used to represent the bus services lines in other parts of the map. For example, a green line was used to represent bus service number 102. Similarly, the green colour was used in the written text for the bus service number 102. This situation is only applicable to the inset of the Geographical Approach bus map. The flexibility in the scale of schematized representation has avoided the Semi-schematic map requiring this technique.

5.2.7 Type of Road Network to Be Presented

Road networks are one of the essential map elements in bus maps. Careful consideration needs to be made on how many roads should be shown on the map as the road networks can become extensive and complicated, especially in urban areas. The map review process managed to highlight three types of road network representation in a bus map. The three types are:

1. Full-road Network: the map that shows every roads and street
2. Main-road only: the map shows a selection of main roads and streets (including all with bus routes).
3. Bus-routes only: the map only shows roads with bus services.

Advice that it is best to not only show the roads used as bus service routes. Other roads not used as bus service routes should be included for spatial orientation and geographical location reference (Evans, 2010). This situation brought up a question about the ideal amount of road detail included in the prototype maps.

The whole road network type is often used by cartographers when presenting a bus map in the Geographical Approach. However, the situation is not the same in schematized representations as this type of map would distort the appearance of road networks, and as a result, only major roads tend to be included, and, in several cases, only bus routes are shown. This research requires bus maps that share similar map elements, varying only in the main style. After careful consideration, it was decided that the prototype maps show the bus service roads and several other major roads. No minor roads will be shown, making it practical to develop comparable maps with both the Geographical Approach and Semi-Schematic representation.

Presenting only a partial road network in the map should not bring any adverse effect as the new whole-network bus map will be used mainly as a route planning map. In a route-planning map, the bus service routes should be made the most distinguish map elements (Morrison, 1996b). Reducing other non-important roads in the map will make the journey planning process much more comfortable as the passenger can see the bus routes that they need to take, the terminal involved, and the interchange locations they need during their journey. Users are recommended to use a separate city map if they need further information regarding the neighbourhoods or surrounding area.

In this study, all the road segments other than bus route roads will share the same colour to highlight the equal hierarchy level that they share in the map. The roads not used by the bus services should be placed in the lower hierarchy level than the roads used by the bus services. Based on this condition, white was chosen to represent these roads. The white colour brings the distinctive contrast needed to separate the roads from bus routes and other map background features represented through various area colours. Indeed, one of the advantages of the inclusion of coloured background areas previously discussed is to allow this ‘active’ use of white as part of the design. The same line width of 0.6mm was used to represent the roads in both maps. All the roads are labelled, with the name road placed beside the road line. Some longer roads have more than one label along the road.

5.2.8 Selecting Landmarks and Other Points of Interest

The map design process continues with consideration of landmarks and other essential points of interest. Besides the road network, landmarks provide invaluable spatial information to the user’s visualisation during the journey-planning process. Map reviews have highlighted the importance of landmark presence and the majority of bus maps include at least some of this type of information. The number of landmarks and other points of interest is a balance between space available, providing information, and avoiding too much distracting the user from the primary task.

Different cultures bring different meanings to key landmarks. In Malaysia, gas stations, religious temples, and education institutions are considered the key locations that shape the users' visualisation during navigation. These kinds of locations have the same weighted value as other visually prominent landmarks, like main tourist attractions, physically attractive buildings, and outstanding landscape features. For this reason, the new whole-network bus maps include more landmarks in these categories throughout the map. The number of landmarks presented is identical in both map forms. Landmark selection was concentrated around the bus service roads.

The next question that arises is what type of symbology should represent the landmarks on the map? The map-reviewed process has found that there are two common types of symbology used to represent landmarks: conventional symbols and pictographic symbols. The findings further show that some form of pictographic symbolization was the preferred way to portray landmark information. In this case, it was decided to use a pictographic symbol (pictogram) to represent each feature type rather than produce an individual pictorial symbol for each feature. The source of images used to create the pictograms was based on the current users understanding of essential symbols and visualisation elements that hold the local area image and identity (Hussain and Ujang, 2018).

In both maps, education institutions are represented by a pictogram of graduation cap, religious establishment represented by the recognisable pictogram of a mosque dome, and gas station represented by a fuel pump logo used extensively as the car fuel indicator (Figure 5.2). All the pictograms were created using Inkscape^{TM}.

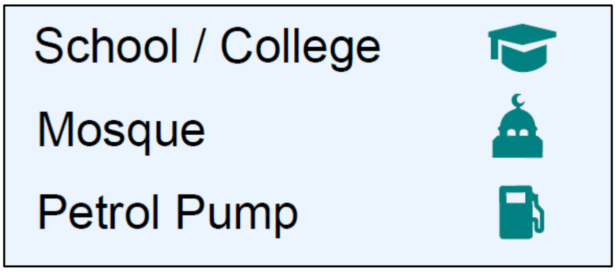

Figure 5.2: Pictographic symbolization used in representing landmarks

In this study, all the termini names were placed beside a symbol representing the terminal location. The termini text was coloured with the same colour used to represent the bus route. For example, bus route number 302 was represented by a purple line so purple text was used in labelling the termini for bus service number 302. All the routes depart from or terminate at the same central bus station in the city centre for the specific research area. A red colour and the larger text were chosen to represent the termini name to highlight this situation's importance.

5.2.9 Typography Setting

The next step is to label and name all the vital map elements that have been placed on the map. It is essential to understand the critical considerations needed in completing this process. The considerations involved during the naming and labelling the map elements include the typeface to be used, the type size, the type case, text spacing, and text colour. The map review analysis did not include any typography analysis, so for this study, the placement and selection of text were based on published design manuals and guidelines.

For the typeface, the guidelines advised sans serif fonts for titles and labels. These fonts are legible and clear enough to be read from a distance and readable by visually impaired users. There is a long list of sans-serif typefaces with Geneva, Arial, Helvetica, and Tahoma among the commonly used. For consistency and map simplicity, only one typeface was used in the whole mapping process. It was decided to use Arial as the primary typeface. The variation of Arial fonts, such as Arial Light and Arial Narrow, makes this typeface very usable in a tight and small space.

The guidelines also offered recommendations about the practical use of type case. The correct usage of type cases can give direct information about the location hierarchies. All capital letters represent public transport terminals and main bus stations as these are the prominent locations that the user needs to know when using the map. The all capital case usage highlights the importance of these features compared to other features. Sentence case was used to label all other locations and map elements.

The type size is the other important typographic attribute that needs to be considered. Cain et al. (2008) discovered that the most prevailing issues among public transport users are small-type sizes in public transport information material. The new whole-network bus map was targeted to be displayed in an outdoor situation, exposing the map to undesirable factors such as poor lighting conditions and a distant viewing situation. The use of the largest type size possible should be made a priority during the design process. For typical viewing distances, most of the guidelines optimally recommend the use of point size between 14-point to 8-point, whichever is applicable depending on the location of the maps. However, due to limited space available faced by maps, Peterson (2014) suggested that the minimum type size for sans serif type can be reduced to 6-point. No type under 6 points should be used as the font would not be readable from any distance. Based on this recommendation, it was decided that this study used a variable font size between the size of 6-point and 24-point. The exact size was then depended on the text purpose and function.

After the specification on typeface, case, and font size have been determined, several modifications need to be implemented to enhance the map readability. There are several types of text modification which can be done, including the variation of characters spacing and different text styles (Italicized text and bold text). Character spacing was used in labelling large areas on the map, such as residential areas and industrial areas. Various residential areas surround Kuantan City, and these residential areas are among the features that shape the identity of Kuantan City. Each residential area has a unique name, and this feature is one of the crucial points of interest used by local people during their journey planning process. The use of character spacing in labelling this type of land feature will reflect the large area covered by each residential area and make locations more identifiable during the map use process. Italicized text was used to label the hydrographic features Kuantan River and the South China Sea. Bold text highlighted significant locations in the map, such as the bus terminal, terminus names, and important landmarks.

As for the text colour, the guidelines advise on the importance of contrast. Any colour can be used provided that the colour gives a high contrast between the text and the background. No reverse polarity situation (the light colour text on dark background) should be implemented as this kind of labelling tends to result in poor readability, especially under a low light situation. It was decided to use various dark colours to represent the text. The colours selected are black, dark green and dark blue.

The last typographic setting that needs to be decided is the text direction. The most straightforward text direction to be used is the horizontal direction. However, there are several situations in the map that make this direction not feasible. In this situation, the placement of text follows a guideline-recommended by Peterson (2014), as shown in Figure 5.3. The diagram shows how to place the text in the most readable direction.

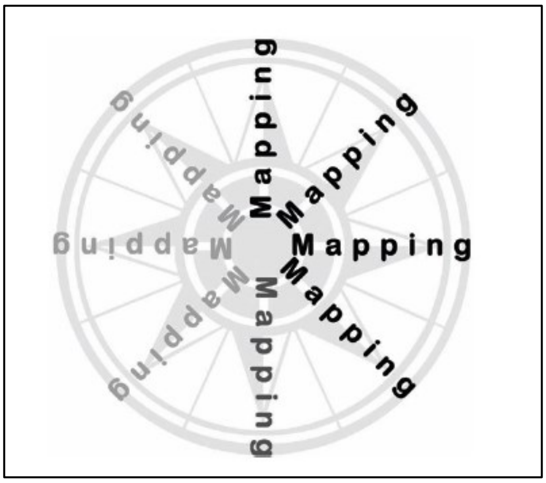

Figure 5.3: Text direction guideline (source: Peterson, 2014)

In this diagram, the most suitable way is placing the text were shown in darker text while the less preferable way is shown in a gradually lighter text colour. No text should be placed across a map feature to maximise the text readability. In general, the text specification used in creating the new whole-network bus map on both types of map forms is shown in Table 5.3.

Table 5.3: The typography settings used in the study

Typography Feature	**Type of Font Used**
Map Title	Arial Rounded – 24 point (Bold)
Bus Service 1. Main Bus Terminal 2. Service Numbers 3. Termini Names	 1. Arial Narrow – 8 Point (Bold) 2. Arial – 6 Point (Bold) 3. Arial – 6 Point (Bold)
Road Names 1. Bus Route Road 2. Other Road	 1. Arial – 6 Point (Italic) 2. Arial – 6 point (Italic)
Points of Interest 1. Prominent Location (Residential Area, Public Park) 2. Other Location 3. Hydrography Feature 4. Landmarks	 1. Arial – 6 Point (Expanded Character Spacing) 2. Arial – 6 Point (Normal with no character spacing) 3. Arial – 6 Point (In Navy Blue Colour) 4. Arial – 6 point (In Emerald Green Colour)
Legend 1. Heading 2. Body Text	 1. Arial – 14 point (Italic) 2. Arial – 10 Point

5.2.10 Map Composition

The whole map design process ended with the placement of legends and other necessary additional information such as map title, map version date, printing time, and placement of north arrow.

While a legend was provided, it does not provide all the map element information. Only information related to the bus services system and key points of interest were included. Headings were used to differentiating the two groups of map elements shown in the legend. For the Geographical Approach bus map, the legend is placed in the right top corner (sea area), while in the Semi-schematic bus map, the legend is placed at the bottom of the map (land area). The different placement of the map legend in the two maps is required as they use space differently. It is vital that the legend does not block the underlying data and does not distract the user during the journey planning process. A background box was used in presenting the legend to enhance legibility.

The same title was used for both maps, with the title carefully selected to keep it short but informative. Proper selection of words can highlight the primary intention of the map in just a single glance. Map titles were written in all capitals and bold style. This was selected to attract the user’s attention and to be readable from a distant viewpoint. The map title for Geographical Approach map was placed on top of the legend box, while the map title for the Semi-schematic map was placed at the legend box's side.

Finally, a north arrow was placed to show the orientation of the map to the user. A North arrow was included in both the Geographical Approach bus map and in the Semi-Schematic approach. The modern mapping trend of using a simplistic logo design to reflect the north direction was adopted in presenting this kind of information on the map.

5.2.11 Map Prototype

After all final details and finishing touches have been applied to the maps, the finished map in both map design formats was exported (in .pdf) from the graphic design software (Inkscape^{TM} Software) before being printed on A2 paper. Figure 5.4 shows areduced illustration of the Geographical Approach bus map, and Figure 5.5 shows a reduced illustration of the Semi-schematic Bus Map. The full-size maps for both map designs can be found in Appendix E.

These maps were the primary research material used in the next stage of this study. The following section in this chapter will discuss the procedure used during the pilot study testing, followed by the subsequent final field test stage

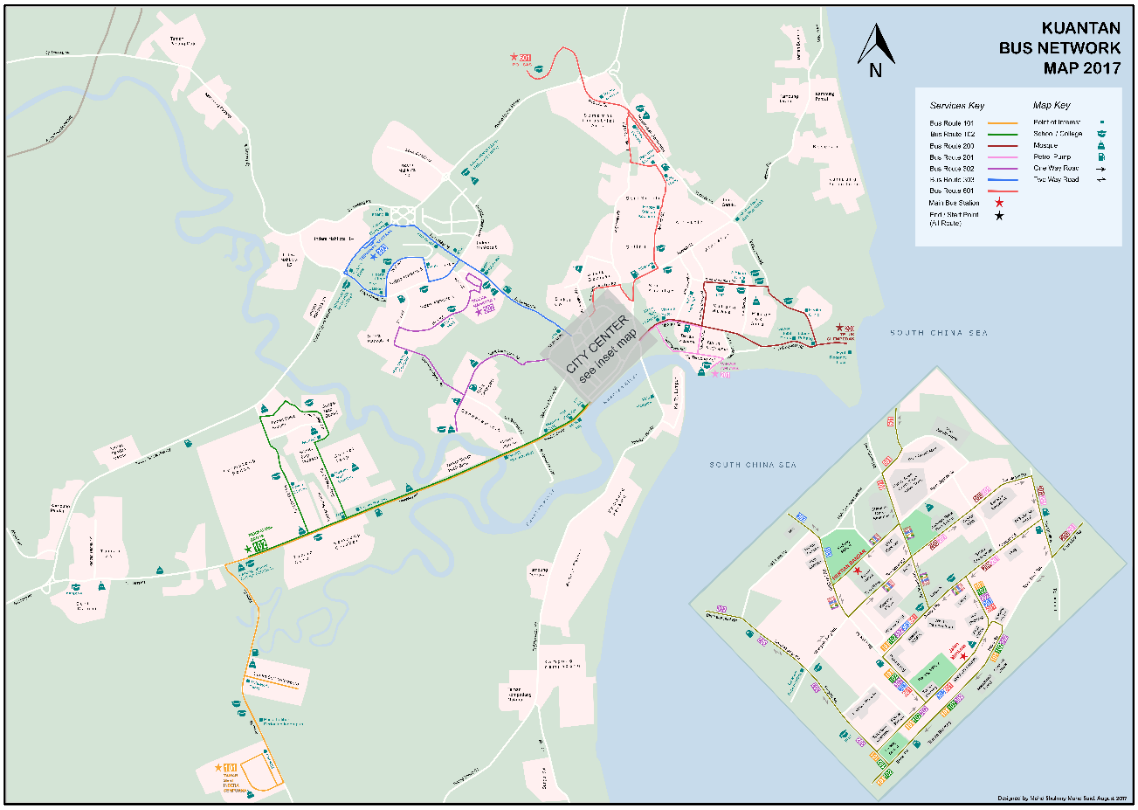

Figure 5.4: Reduced Illustration of The Geographical Approach bus map

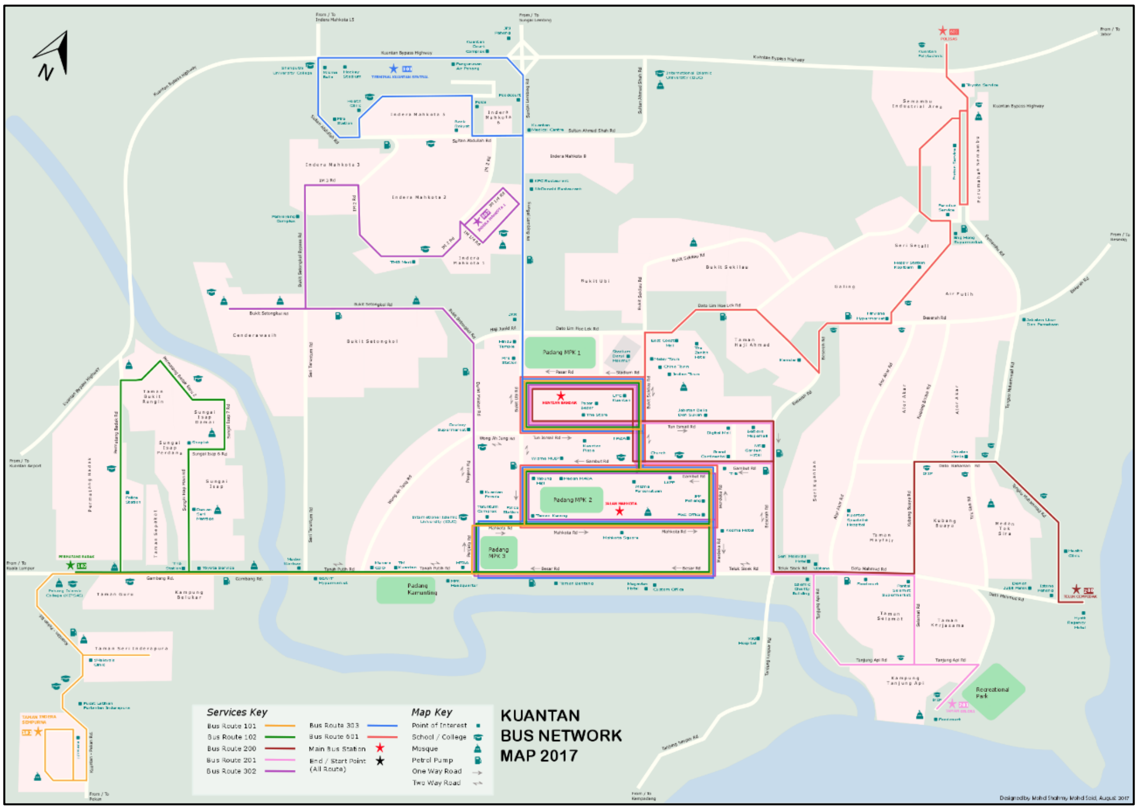

Figure 5.5: Reduced Illustration of The Semi-schematic bus map

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5.3 Testing the Whole-Network Bus Map

After the two whole-network bus maps have been created, the research process focuses on the map usability test. This section describes how the new whole-network bus map concept was tested, starting with a pilot test to check the materials and process. The subsequent field test was performed after several refinements were made to the research procedure and the research material. All the final field testing was conducted in Kuantan, the capital city of Pahang State in Malaysia.

5.3.1 Pilot Test

The pilot test's primary purpose was to identify any problems with the overall data collection process. All the fieldwork procedures and test instruments were tested, which permitted improvements if any flaws were discovered. The pilot test also gives the interviewer experience in handling real situations in the fieldwork process. A sample of ten respondents completed the pilot study process. This resulted in each survey variant being tested twice and a total of 60 journey-planning tasks being completed. These respondes were only used for the pilot study test and not included in the final test.

A preliminary reconnaissance visit to the potential map testing area was done a week before the pilot testing took place. This test was conducted to ensure the safety, security, and comfort of both interviewer and participants. The researcher asked for help from experienced bus users and local people to ensure these factors were not compromised. During this reconnaissance, the researcher was able to find a safe and secure place to conduct the study.

Usability testing (Nivala, Brewster and Sarjakoski, 2011) was adopted as the central concept for this test. In general, the basis of concept is that a small number of respondents is adequate to identify any significant problems that the overall population would face when using a product. This means that any issues with the whole testing procedure, including the questionnaire's design and maps used, could be identified through this pilot test study. The City of Kuantan was chosen as the place to conduct the pilot study test. The test was done at the bus stop/stance/station, and due to the cultural norms, the test was also done at the user's preferred location place (home, café, public park). These are in line with the controlled testing method, which is the backbone of this research methodology.

The pilot tests were done over four days, from 22nd July 2017 to 25th July 2017, at various times from morning to the end of bus operating times. The four days selected were from Thursday to Sunday, which helped the researcher assess the full range of bus users on weekdays and the weekend. During the pilot test, the interviewer position himself in several main transportation hubs across the research area. The interviewer intercepted an individual respondent politely, and after a brief introduction, the respondent was directly asked about their further journey planning and their willingness to take part in the test. Respondents required sufficient time available to reduce uneasiness while taking the test. However, this respondent approach method proved to be ineffective as the interviewer struggled to find willing respondents. An alternative approach was taken for the primary fieldwork, discussed in the next section.

On the first and third days of the pilot test, the test was done at several transportation hubs around residential and industrial areas. The people in these locations provided the researcher with views and responses from local communities. On the second and fourth days, the test was done in a public higher education institution and commercial area. Conducting the test in these places enabled the researcher to gauge feedback from the main bus users in the research area. The pilot test ended on the fourth day after the researcher managed to get the ten respondents required for this pilot study. In total, 30 people were being approached by the researcher, but only ten were willing to be respondents.

5.3.2 Key Findings from the Pilot Tests

In general, the test was completed successfully without any significant problems. However, the pilot test provided several insightful and significant findings to help the researcher conduct the final field test. The key findings are as follows.

a) Performing Map Usability Tests at Bus Station/Stop/Stance

It was clear that it would be challenging to obtain the target response rate if the test was only done at the bus station/stance/stop. This case is in line with what Evans (2010) experienced, as he struggled to achieve the target response rate when conducting surveys at bus stations. Obtaining willing respondents is problematic because the people’s attention is focused on checking the bus schedules and looking out for approaching buses. It gets harder even when the researcher manages to get a willing respondent because most people are there for just a little time. They are there just in time before their preferred buses arrive. Many people also politely declined to take part, a norm for field research that involves public participation in the country.

For this reason, additional measures in approaching respondents were essential. In addition to approaching people waiting at a bus stop, it was decided to pre-arrange the time and place to conduct usability testing with the willing respondents. These steps proved successful as many respondents agreed to spend some of their time participating in the test. Thus, respondents were more comfortable and cheerful while answering the questionnaire, resulting in a better response in the test. These measures certainly improved the efficiency of this test.

b) Time for Conducting the Test

The time for the test is another factor that affected the efficiency of the fieldwork. The overall mood of bus users is different based on the time of the day, which directly impacts their willingness to respond to the researcher's approach. People seem to be responsive and want to participate in the research during the early morning or late evening. This situation may coincide with the extreme weather conditions in the research area. In the middle of the day, the temperature can easily reach 35 degrees Celsius, an uncomfortable temperature to stay outside and perform a test. This situation worsens with heavy rain. The monsoon rain made it harder to carry out any conversation due to the high level of rain-tapper sounds and directly affected test material. This condition highlighted the need to perform the test in an indoor situation during the bad weather, without entirely abandoning the need to perform the outdoor test.

c) Alteration to the Maps and Research process

Most pilot test respondents completed the map usability test and subsequently answered all the questions on the form. After reviewing several comments, there was a need to improve the map design's overall legibility and the introductory part of the research. The main design issues identified from the test are the text font legibility (typography) and the text placement. Older respondents mainly highlighted this issue. The researcher changed the font used in the maps to solve this issue. The new typeface used is still a san's serif style. As the font has been changed, there was also a revision of text placement to accommodate the size increment without affecting the background information's contrast level. The text colour also changed by using a darker colour instead of using a variation of lightness in colour. Respondents did give some comments about the use of variable text spacing and text boldness as these measures have helped them to grasp the hierarchical differences between several locations and points of interest in the map. All these steps have improved the clarity and overall textual representation in the maps.

In terms of the overall research process, a small terminology change was made to the introductory documents to help users feel more welcome to participate in this test. The questionnaire form was revising to include the phrase "to be completed in the shortest time possible," in a move to highlight the importance of time efficiency in planning their shortest journey. To avoid any blank response to any section in the questionnaire form, a "Do not Know" option was included in all related sections. There were no other significant issues found during the pilot test. In general, the test instrument and materials were found to work efficiently.

5.3.3 The Final Field Test Overview

After the feedback and recommendations from the pilot test had been addressed, all the test materials were ready for the final map usability test. The final testing of the maps took place throughout August 2017 across the City of Kuantan, Malaysia. In total, 100 respondents were involved in this final field test.

The first test session took place in a controlled environment situation. Pre-discussion had been made with some potential respondents at a local public higher education institution. Most students and staff at this education institution use the bus daily. The testing carried out in this location proved successful since the researcher managed to get an excellent response from the people there. They were easily approached and quickly agreed to be respondents. This is because the people in an academic institution are accustomed to this kind of research. Thus, it does not create any awkwardness or an uncomfortable situation when the researcher approaches the respondent. The respondent’s age in this location is ranged from 19 years to 35 years old.

The controlled environment area testing was then continued at a local government office. Government workers are the other main contributor to the usage of buses in Kuantan. By performing the test in this area, it gave another crucial input into this study. In this location, the researcher managed to expand the respondent range from 25 years old to 50 years old. The difference in the respondent’s socioeconomic background in this area has given a better perspective to the study.

The next location for controlled testing was at the city’s main bus operator office, RapidKuantan Sdn. Bhd. By getting the respondents from the primary operator for the bus services in the research area, it is fair to say that the study has covered an end-to-end subject in a bus services component system, right from the bus provider to the end-users. The responses that the researcher got from RapidKuantan staff were significant for the study and will help build a strong link after the final analysis. In total, two weeks were spent on these controlled environment test situations.

Testing was then continued for the open environment test situation. The researcher started these tests at the main bus terminal and main bus station before gradually approaching bus users at a smaller bus stances and bus stops. As a lesson had been learned from the pilot study, the tests only took place during good weather days and only in the morning or evening hours. The researcher only approached the bus users who just arrived and had a longer waiting time for their next bus. In addition, several bus users agreed to take the map usability test at an arranged time by giving their preferred place, date, and time. Besides performing the test at the places mentioned above, the researcher also went to public locations and public recreational places around Kuantan's city in pursuance of willing respondents. Two weeks were spent on this open environment test situation. Although the number of respondents was not as many as the number of respondents in the controlled environment areas, their views, responses, and answers were significant.

5.4 Conclusion

Analysing and classifying in detail the current cartographic approaches to bus map design is indeed a challenging process. This challenging situation is because there are a variety of different cartographic design and visualization techniques that are currently being practised. Nevertheless, the resulting classification developed has helped to identify the particular considerations that should be taken into account when designing a bus map in a specific context. By conducting the bus map review and analysis, it is hoped that this research can stimulate further research in this topic and subsequently bring more understanding about how bus maps work for the benefit of the map user.

The map review analysis findings have already proven useful during the map design process for the two map prototypes in this study. The review gave an immediate understanding of the current cartographic representations used in bus maps. With the understanding of this variation, the map design process was smoother as the map maker has a better perspective on delivering the right information in the most appropriate style. This situation has been exemplified throughout the map design process of this study.

As for the map testing process, overall, the final data collection stage in the City of Kuantan was successful. The researcher managed to get ten respondents for the pilot study and 100 respondents for the final field test, fulfilling the research methodology criteria as set out in Chapter 4. The respondents also gave useful answers and feedback on the questionnaire form, which will allow the researcher to carry out data analysis. The field test has also allowed the researcher to expose people in the research area to the importance of cartography in enhancing bus information provision and the importance of maps for the community in general. The next chapter will focus on data analysis, which involves a full assessment of the responses to evaluate the new whole-network bus maps' effectiveness and find out which map is preferable to be used.

CHAPTER 6

Results and Discussion

6.1 Introduction

This chapter presents the results of the field tests to evaluate the potential impact of the Whole-Network bus map concept for the bus users in the City of Kuantan, Malaysia. The two forms of network maps evaluated are the Geographical Approach bus map (Geo bus map) and the Semi-schematic bus map. A summary of sample profile is followed by a comprehensive analysis of various aspects of the map usability testing to compare both forms of the network map's performance and user preference. The discussions about the potential future usage of the preferred map are included at the end of this chapter.

The analysis is in the form of a detailed statistical analysis of various aspects of the map usability testing to compare the two maps' performance. The statistical analysis starts with a descriptive analysis of data for all independent and dependent variables. This analysis will give direct findings on the following variables:

1. Age and gender of respondents;
2. Travel habits of respondents based on the availability of driving licenses, access to a car, and frequency of bus use;
3. The degree of correctness for the journey-planning tasks.
4. Landmark number adequateness;

Since Likert scales have been used in the questionnaire form, which cannot be assumed to be continuous, non-parametric statistical analysis was performed on selected variables. A Kruskal-Wallis one-way analysis can be performed to gauge the respondent’s confidence level. The non-parametric statistical analysis will give finding for these variables:

1. Ease of map use;
2. Increase future bus use through maps.
3. Map preference.

6.2 Analysis of Sample profile

This research treats every person in the City of Kuantan as a potential map user, and there is no limitation on the type of people that can participate in this research. Since this study is exploratory research in nature for the study area, the purposive sampling approach was used as the main instrument to attract participants. Respondents were tested at his or her own preferred time and place. This sampling approach proved useful as the researcher managed to achieve the target number of respondents needed, with excellent feedback during the map usability test. The details of the sample profile are shown below.

6.2.1 Gender and Age of Respondent

The total number of respondents gathered for the final map usability test is 100. These 100 respondents come from various backgrounds representing the bus users and the potential bus users in Kuantan. There is a balanced split between male and female. respondents. In specific, there are 54 male respondents and 46 female respondents.

One of the crucial factors that define travel behaviours, needs, and options is age. Cohort Analysis was used in this section, where several different age groups defined respondents. Different life cycle stages can account for different patterns of travel behaviour (Oppermann, 1995). The use of cohort analysis permits the observation to be performed on the respondent's actual natural life cycle (Allistair and Benjamin, 2013). This study classified the age of the respondents into four age groups (Table 6.1).

Table 6.1: The respondent's age group

Age (Years Old)	Numbers
18-24	58
25-34	17
34-49	20
50-64	5

From Table 6.1, most respondents came from the age of 18 to 24 group. This is mainly because the primary bus users in Kuantan came from this age group and are the typical age of respondents that are still studying in local colleges and higher education institutions around the research area (Ponrahono *et al.*, 2015). The age group of 25-34 and the age group of 34-49 were reasonably well represented, and they represent most of the professionals currently working in the research area. There was notably a low number of respondents in the age group of 50-64 as the users in this group were reluctant to participate in the journey-planning task, and even if they started the test, several did not complete it. Nevertheless, the proportion of total numbers in each age category is reasonably consistent with bus service users' age profile in the research area. The purposive sampling technique has helped the researcher to achieve this balance.

6.2.2 Travel Options for Respondent

To understand whether a new whole-network bus map can help improve bus usage in the research area, the researcher needs to know the respondents' travel options. The information on the availability of a driving license and access to a car/motorcycle will indicate if other travel options are likely.

Table 6.2: Respondent mobility option

Items	Yes	No
Availability of Driving and Riding License	81	19
Access to a car / motorcycle	95	5

Table 6.2 shows that a large majority of respondents have a license (81 respondents), and they have easy access to either car or motorcycle (95 respondents). The high percentage of respondents with both car license and easy access to a private vehicle is not surprising since Malaysia has the third highest car ownership globally, with 93% of the total population having a car (Nielsen Global Survey of Automotive Demand, 2014). Malaysia also has the highest case of multiple car ownership, with 54% having more than two car ownership. The car owners believe the car is a symbol of success, which results in this high car ownership. Additionally, as mentioned in Chapter 2, the bus service previously was not good and is hampered by a bad reputation. The perceived best option for people to travel from one place to another is by using their own vehicle. It is also a norm in Malaysia to acquire a driving/riding license soon after finishing high school study and subsequently buy a car soon after securing any job.

6.2.3 Current Bus Use Profile

Another factor that may influence the respondent’s performance when performing the map usability test is bus usage frequency and their experience in using the bus transportation system. Table 6.3, 6.4, and 6.5 shows information about the respondent’s bus usage experience.

Table 6.3: Bus usage experience

Bus Usage Experience	Yes
Yes	86
No	14

Table 6.4: Bus usage frequency

Bus Usage Frequency	Number
Never	14
Once per month	47
Three times or twice per month	22
Once or twice per week	8
More than thrice per week	9

Table 6.5: Other public transport use

Other Transport Usage	Number
Yes	63
No	37

Although there was a high number of respondents that have experience in using the bus (86 respondents), the tables above clearly show that the bus was not the preferred transportation mode for most respondents; more than half of the respondents (61 respondents) used the bus only once a month or less. In comparison, 22 respondents use the bus thrice or twice per month, followed by another 17 respondents, which used the bus more frequently (more than one use per week).

Nevertheless, this shows that the respondents reasonably represent each different bus user group, which compromise a group of avid bus users, a group of moderate bus users, and a group of potential future bus users. This result presents a perfect stage to measure whether a new whole-network bus map design can entice them to make more use of buses in the future.

6.3 Effectiveness of Whole-Network Bus Maps

It is essential to deliver useful public transport information so that the user can plan their journey effectively. Three criteria were measured to know the effectiveness of the two bus map designs. The first criteria is the journey-planning task's correctness; the second is by the respondent's rating of the ease of map use, and the final criteria are the respondent's confidence level while using the map.

6.3.1 The Degree of Answer's Correctness

In examining the respondents' answers, all the valid answers were allocated to one of four possible categories of correctness. This category was guided from the technique used by Morrison and Forrest (1995).

1. Correct Solution and Optimum Answer
2. Correct Solution, but Non-Optimum Answer
3. Wrong Solution
4. No response

One of the essential aspects of this new whole-network map design is to enable the user to select the correct bus services and select the optimum services available in completing their journey. That is why it is vital to measure the correct answer in two different categories. Similarly, it is crucial to differentiate the wrong answer from no answer being given. Users providing a wrong answer could indicate that the map contains misleading or unclear information, while a no response answer could indicate that the map does not provide enough information or is too complicated for the decision-making process.

The respondents completed six map journey-planning tasks. Each respondent completed all tasks, and in no case did the participant fails to answer. From the total of 600 tasks completed by the 100 respondents, only 35 tasks (6.0 %) were somehow incorrectly completed. Twenty-two of these non-correct answers were within the Geographical Approach bus map journey-planning task and the remaining 14 during the use of the Semi-schematic bus map.

Table 6.6 shows the outcome of the map usability tests in each category.

Table 6.6: Result of the journey-planning task

Network Map / Degree of Correctness	Geographical Approach Map			Semi-Schematic Bus Map		
	Task 1 (%)	Task 2 (%)	Task 3 (%)	Task 1 (%)	Task 2 (%)	Task 3 (%)
Correct and Optimum	89	83	83	97	95	87
Correct Service, but Non-optimum	11	8	4	3	2	2
Wrong Service	0	9	13	0	3	11
No Answer	0	0	0	0	0	0

Overall, a relatively high number of respondents gave a correct and optimum answer for all the tasks undertaken. Five hundred thirty-four tasks (89%) were done in a correct and optimum way, with only 30 tasks completed correctly but not in an optimum way. Task 1 saw all the respondents give the correct answer. The wrong answers were first seen in Task 2, and the numbers rise in Task 3. These two tasks require the user to select two or more services to complete a single journey. Users show a slightly better journey-planning performance using the Semi-schematic map (87% to 97% correct and optimum answer) compared to when they use the Geographical bus map (83% to 89% correct and optimum answer). However, the exceptionally high percentage of correct and optimum answers (more than 80%) given by the respondents proves that either type of network map design could help travellers plan their bus journey.

6.3.2 Ease of Map Use Rating

The result of the journey-planning task indicates that respondents were more successful using the whole-network bus map in Semi-schematic form rather than in the Geographical-approach bus map form. The respondents were then asked about how easy they found it to plan their journey and how confident they felt when planning their journey with each map format. The Likert scale usage to gauge the respondent's opinion in this matter can help get a more defined answer and provide more consistency in findings.

For the ease of use, the respondents rated how easy they found using each bus map form to complete the journey-planning task on a scale of 1 to 5, where:

1 = Very Difficult,

2 = Slightly Difficult

3 = Neither Easy nor Difficult

4 = Slightly Easy

5 = Very Easy

The result of the ease of use rating for each form of the map is shown in figure 6.1.

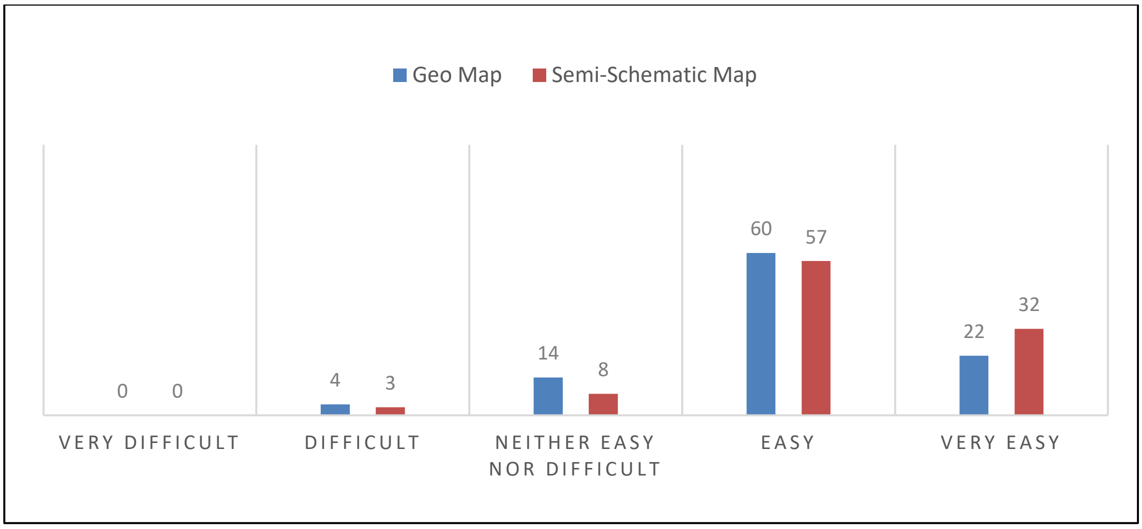

Figure 6.1: Ease of map use

Overall, 89 respondents stated that they found it 'Very Easy or Easy' to use the Semi-Schematic map when planning their journey planning task, compared to 81 respondents for the Geographical map. At the other end of the scale, three respondents said that the Semi-schematic map was 'Difficult or Very Difficult' to use, compared to four respondents for the Geo Bus Map.

A Wilcoxon Signed-Rank test revealed a statistically significant relationship between the Ease of map use between the two map forms, $z = -2.116$, $p = 0.034$, with effect size ($r = .21$). Although the median score rating was the same (4.00) for both maps, the analysis shows that the respondent felt slightly more at ease when using the Semi-schematic bus map than the Geo bus map.

These results suggest that the respondents react positively to the availability of a full-network bus map to improve the current bus transport information provision, with, once again, the favourable map in the form of the Semi-schematic bus map.

6.3.3 Confidence Level in using the Bus Map

It is also essential to find the confidence of respondents in using each style of map. They are more likely to use the bus if they feel confident about their journey, and this will put more faith in bus transportation systems in the future. The right form of a map can instil the belief that the bus system is efficient and easy to use, and they know they can complete the correct journey with confidence.

Respondents were asked to rate how confident they were in the answer they made in each journey-planning task. The rate is once again on the scale of 1 to 5, where:

1 = Not at All Confident

2 = Not Confident

3 = Neither Confident or not Confident

4 = Fairly Confident

5 = Very Confident

The result of the confidence level rating for each form of a map is shown in Figure 6.2.

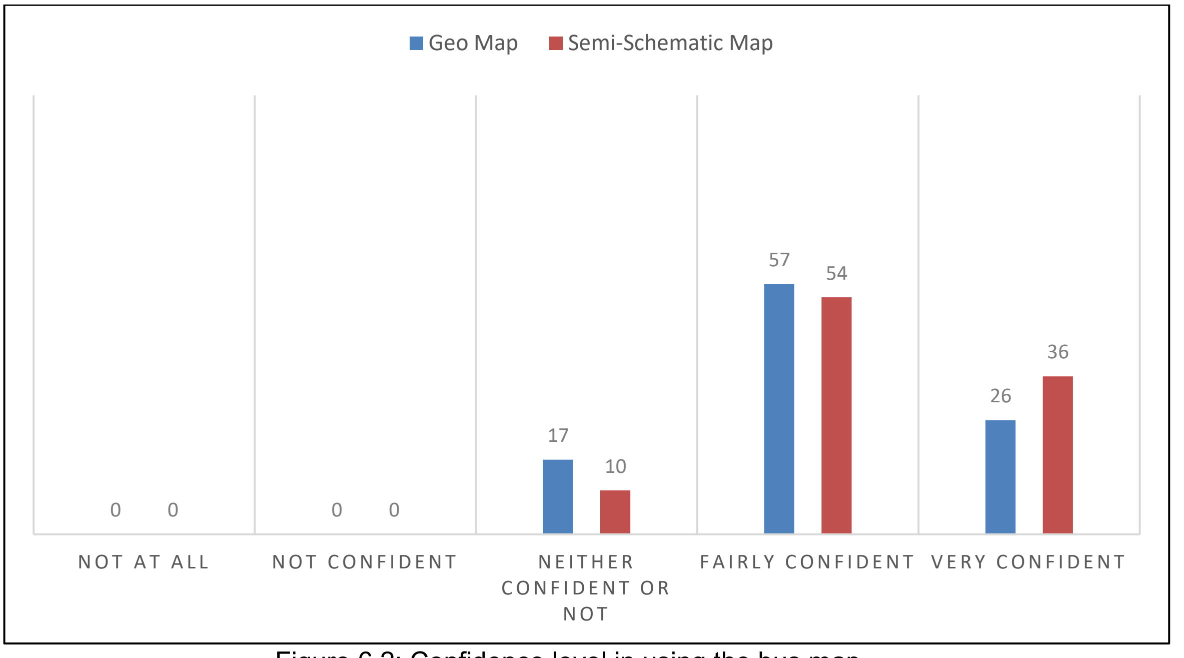

Figure 6.2: Confidence level in using the bus map

In general, 90 respondents felt confident when using the Semi-schematic bus map, compared to 83 respondents when using the Geo bus map. No respondent felt no confidence in using either of these network maps. Only 10 of them that unsure of their confidence in using a Semi-schematic map and 17 respondents for the Geo bus map.

A Wilcoxon Signed-Rank test revealed a statistically significant relationship in terms of confidence level in using these the two map forms, $z = -2.229$, $p = 0.02$, with effect size ($r = .23$). Although the median score rating was the same (4.00) for both maps, the graph's positive skewness shows that the respondent slightly felt more confident when using the Semi-schematic bus map than the Geo bus map.

6.4 Bus Map Design Preference

After learnt about how well the respondents felt about the ease of use and confidence level, respondents were asked directly about their map preference. This question was asked after the respondents had completed all the journey-planning tasks based on both map forms. The map preference results shows that 67 respondents prefer the Semi-schematic bus map compared to 33 respondents that prefer the Geo bus map.

The map preferability factor is further analysed to find out whether the Semi-schematic bus map design continues to be the most prefer map design throughout all the categories of respondents.

6.4.1 Map Preference by Gender and Age Group

a) Relationship between Map Preference within Gender

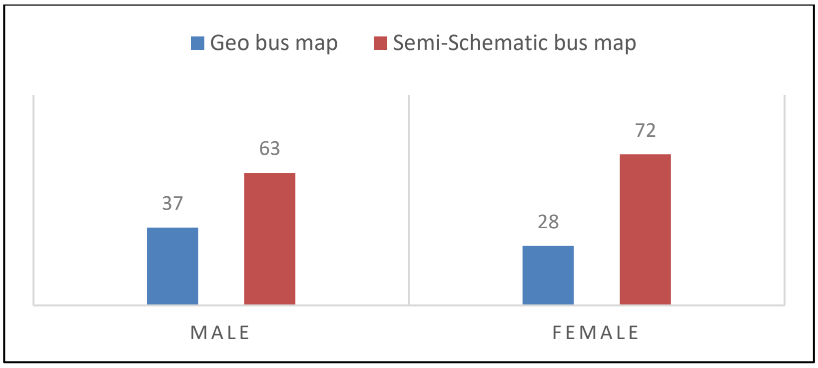

Figure 6.3: Map preference according to gender (in percentage)

Figure 6.3 shows that about two-thirds of both genders prefer the semi-schematic bus map, with 72% of female respondents and 63% of male respondents preferring this map form.

A chi-square test for independence was performed to determine whether there is an association between map preference and gender. The test indicated that there are no significant association between gender and map preference, $X^2(1, n=100) = .514$, $p = .47$, phi = .093. The proportion of males' map preferences is not significantly different from the proportion of map preferences of females, which means that the preferred map was not exclusive to a single gender.

b) Relationship between Map Preference within Age Group

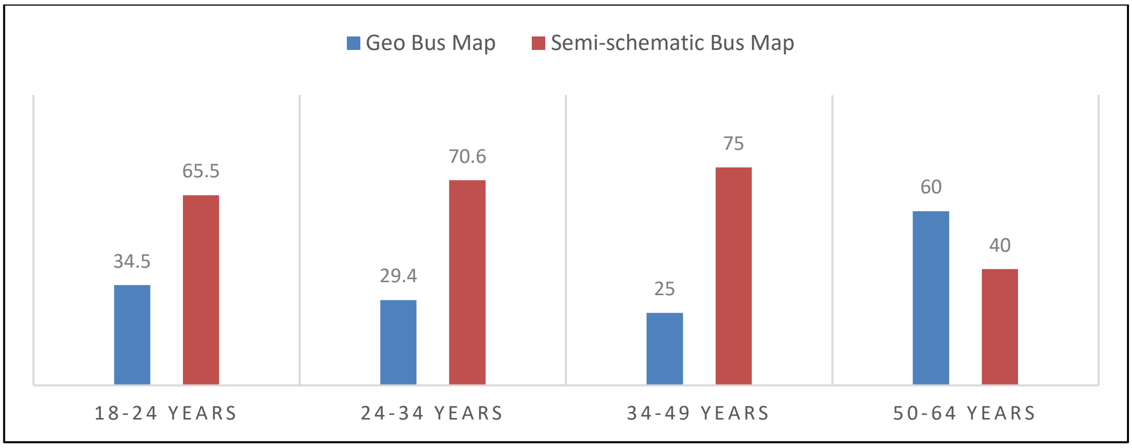

Figure 6.4: Map preference according to age group (in percentage)

Figure 6.4 shows that almost every age group prefers the Semi-schematic bus map over the Geographical bus map. Only respondents from the age group 50-64 have a greater preference towards the Geographical bus map. However, a chi-square test indicated that there is no significant relationship between map preference and age group, $X^2(3, n = 100) = .154, p > 0.05$.

6.4.2 Factors Influence Map Design Preference: Travel Choice Availability

a) Map Preference with Availability of Driving or Riding License

63% of respondents who have a driving license prefer the map in a Semi-schematic form compared to 37% that prefer the Geographical Approach bus map form. On the other hand, 84% of the respondent that do not have a valid driving license, prefer a bus map in Semi-schematic form over the Geographical bus map form (16%).

The chi-square test indicated no significant relationship between map preference and the availability of driving license $X^2(2, n = 100) = 3.142, p = 0.076$. The result means that respondents indeed prefer the bus map in Semi-schematic form regardless of their driving license status.

a) Map preference with the availability of car/motorcycle access

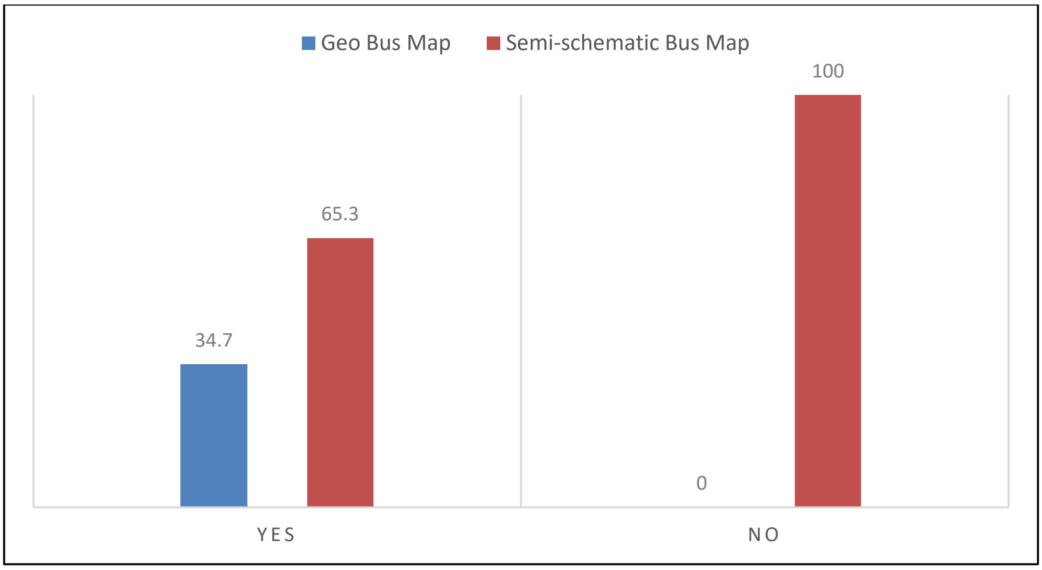

Figure 6.5: Map preference according to regular vehicle access (in percentage)

Figure 6.5 shows that 65% of respondents who have regular access to a vehicle prefer a map in a Semi-schematic form compared to 35% with more preference towards the Geographical Approach form. On the other hand, 100% of the respondent that does not have regular access to a car or motorcycle, chose the semi-schematic form over the geo form.

A chi-square test was conducted, and the test indicated no significant relationship between map preferences and the regular access to car/motorcycle (P = 0.168), meaning that regular access to a vehicle does not have any effect on map preference rating.

6.4.3 Factors Influencing Map Design Preference: Current Bus Usage Profile

a) Map Preference with Current Bus Use Experience

The choice of map preference based on the respondents' records on their previous bus user experience is as follows. 65% of the respondents who have experience using the bus prefer the map in the Semi-schematic form. The respondent that does not use the bus followed this sentiment with 79% of them prefer the maps in Semi-schematic format.

b) Map Preference with Current Bus Use Frequency

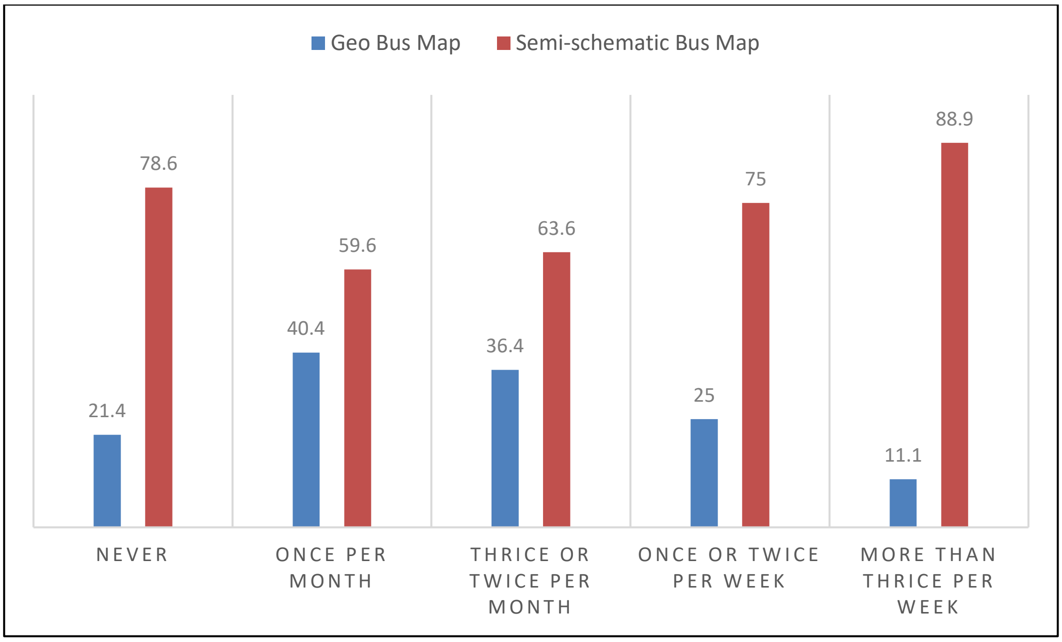

Figure 6.6: Map preference according to the frequency of bus use (in percentage)

Figure 6.6 shows the in-detail analyses about the map preference based on the respondents' bus use frequency. Overall, the Semi-schematic form was chosen as the preferable map in all categories, with frequent bus users (use the bus more than three times per week) having the highest percentage in their class favouring the Semi-schematic bus map over the Geographical bus map.

Further non-parametric tests confirmed that the map preference does not have any statistically significant different both in terms of bus usage experience ($X^2(2, n = 100) = .320$, $p = 0.572$), and bus usage frequency ($X^2(4, n = 100) = 3.348$, $p = 0.501$). The respondents' preferable map is consistent across all user experiences they have with bus services.

6.4.4 Factors Influencing Map Design Preference: Confidence Level Rating and Ease of Use Rating

a) Map Preference based on Ease of Use rating

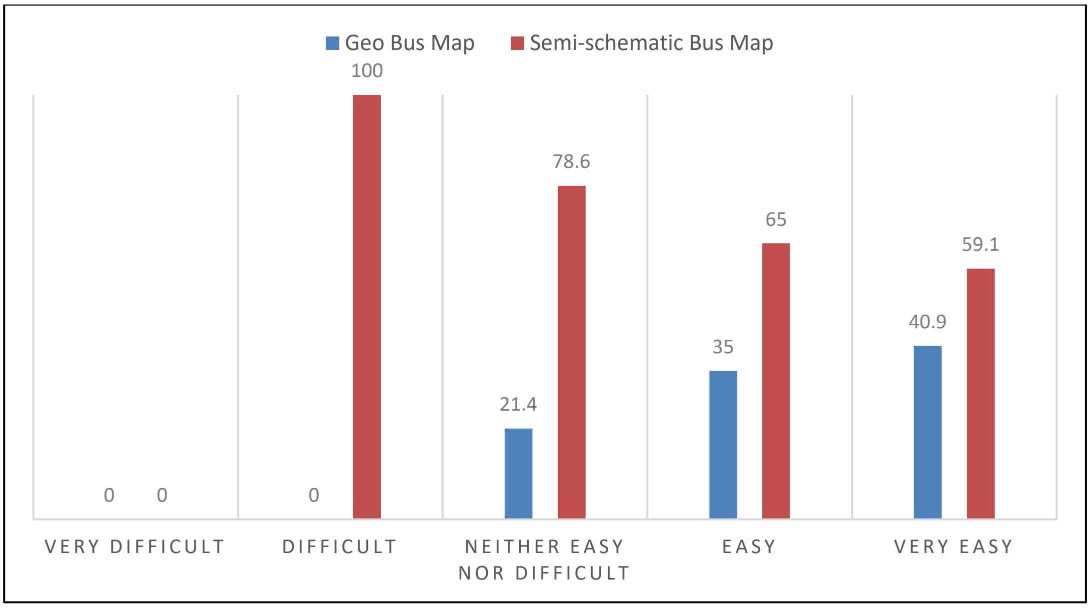

Figure 6.7: Map preference according to the ease of use of the Geographical bus map (in percentage)

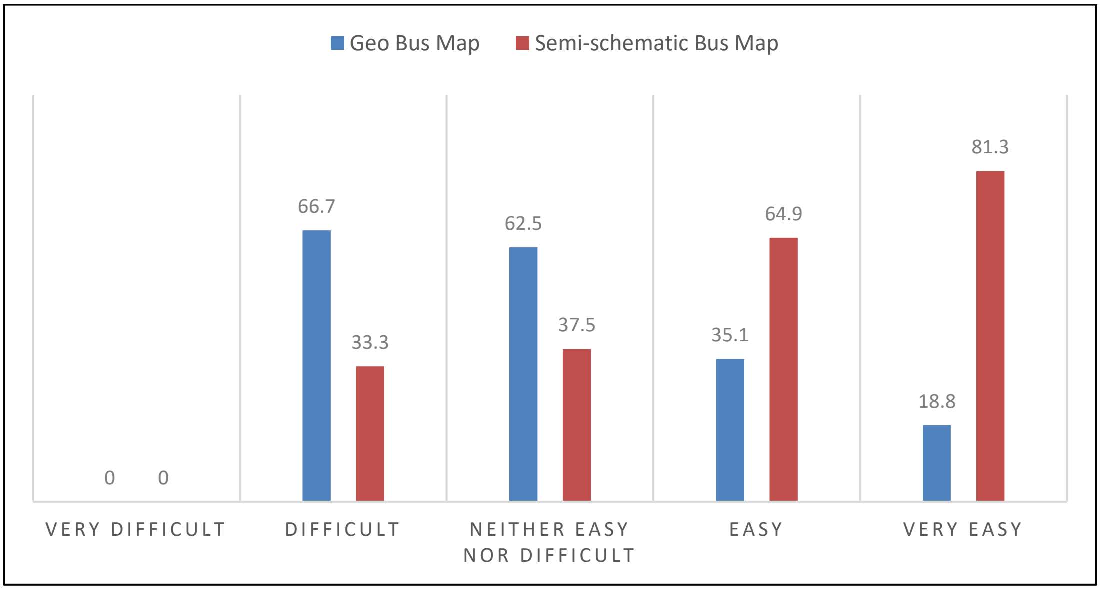

Figure 6.8: Map preference according to the ease of use of the Semi-schematic bus map (in percentage)

The bar graphs (Figure 6.7 and Figure 6.8) show the map preference percentages based on the ease of use rating given by the respondents during the map test. The findings are similar to those observed in the previous analysis. More than half of respondents prefer the Semi-schematic map, although they found it easy or very easy (65% and 81%) to use Geo bus map form.

At the other end of the scale, the respondents found the map that they were using challenging to use; they have chosen the other map as their preferred map. All the respondents who found the Geo bus map challenging to use and 77% uncertain about the easiness to use the Geo bus map have chosen the Semi-schematic map as their preferred map. On the other hand, 67% of respondents who found the Semi-schematic bus map challenging to use preferred the Geo bus map. Once again, this shows that the respondents' map preferences are related to what they feel (ease of use) after using the map.

b) Map Preference by Confidence Level Rating

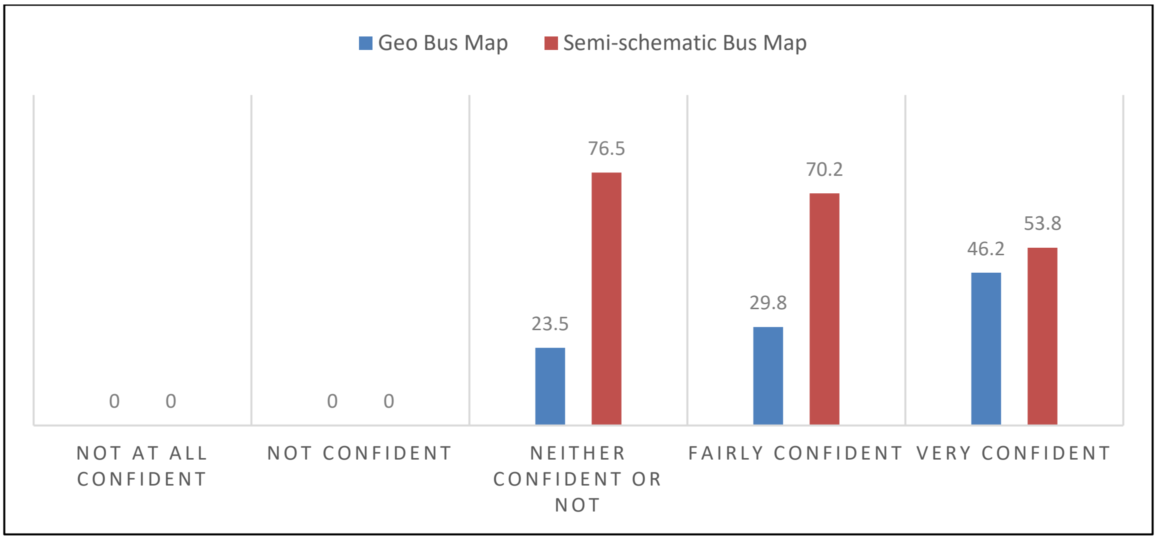

Figure 6.9: Map preference according to the confidence level of the Geographical bus map (in percentage)

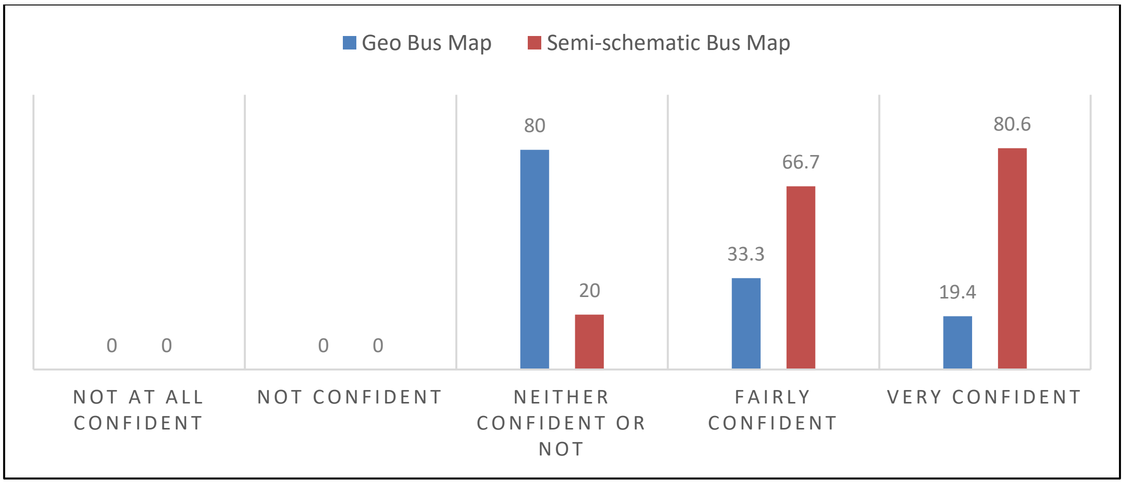

Figure 6.10: Map preference according to the confidence level of the Semi-schematic bus map (in percentage)

The above bar graphs (Figure 6.9 and Figure 6.10) show the map preference percentages based on the respondents' confidence rating during the map test. Once again, when the respondent reported that they were unsure whether the map could help them, they have acted accordingly by choosing the other map as their preferred map. 77% of respondents unsure about their confidence level while using the Geo bus map have selected the Semi-schematic bus map as their preferred map. The same goes for when the respondents rate their confidence level after finishing the journey-planning task using the Semi-schematic bus map. Eighty per cent of the respondents unsure about their confidence have selected the Geographical bus map as their preferred map.

A Mann-Whitney U test backs up these findings as the test revealed a statistically significant association between the map preferences with the confidence level's answer rating. ($U=1423.5$, $Z = 2.637$, $P < 0.05$, $r = 0.264$). These analyses confirmed that the respondents' preferred maps are influenced by what they feel (the ease of use) after using the map.

6.5 Effect of Whole-network Bus Maps in Increasing Future Bus Use

Previously, the results and analysis have shown how the respondents react to their map use and preferences for both maps. With help from the maps, the respondents not only managed to answer the journey planning tasks correctly, but they also appear to have greater confidence and do not have any significant difficulty while performing the task on either map design.

There is one question left to answer: will the maps increase bus usage in the future? The answer to this question might attract the bus providers' and local authorities' interest if the availability of maps can increase the number of bus users, which not only will bring more profit to the bus provider but also help the local authority in promoting a modal shift to public transport usage.

Respondents were asked to rate how likely they would be to use the bus in the future should suitable maps become widely available in their area, in a scale from 1 = Very Unlikely, to 5 = Very Likely. Like the previous map preference approach, the respondents' inputs need to be treated with extra caution to avoid bias. In this question, the respondent may compare their experience in using the new bus map form with their previous experience in using the bus.

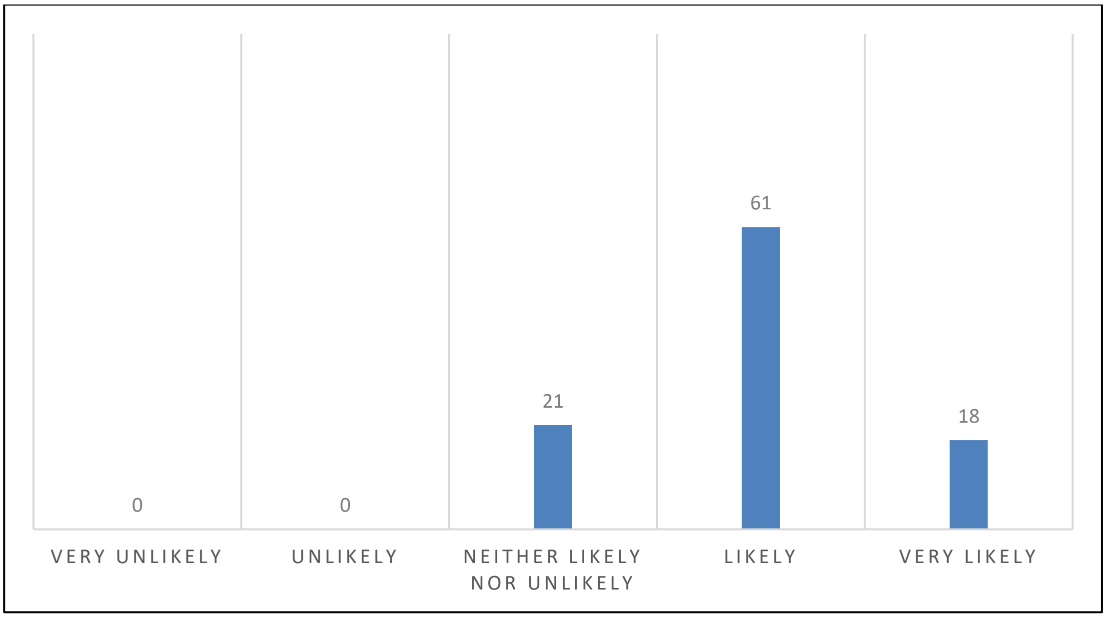

Figure 6.11: The future bus use potential

Figure 6.11 presents the breakdown of the respondent's responses regarding their potential to use the bus in the future. Generally, the respondents felt that the whole-network bus map, should it become available, could indeed influence them to use the bus in the future. As shown in the graph, a total of 79 respondents rated that they are likely or very likely to increase their future bus usage. The median score through the whole sample is 4, suggesting that more widespread availability of network bus maps could substantially impact the future of bus use. Only 21 respondents were unsure whether these maps could persuade them to use the bus more frequently in the future.

Some respondents stated that there are no bus services directly connected to their home, and several further commented that bus services are too impractical for their daily life routine. Given this situation, there is little possibility that they will increase their future bus use without improving other aspects of bus services.

Further analysis found out that the likelihood of future bus use did not depend on the map design preferences, either the Geo bus map or the Semi-schematic bus map, as shown in figure 6.12. A Mann-Whitney U test revealed no significant difference in for the future bus use of Geographical bus map (Md = 4, n = 33), and Semi-Schematic bus map (Md = 4, N = 67), U = 1186.5, Z = .0.682, p = .495. These numbers mean that the user acknowledges a network map will improve the current bus transportation system, regardless of the map format.

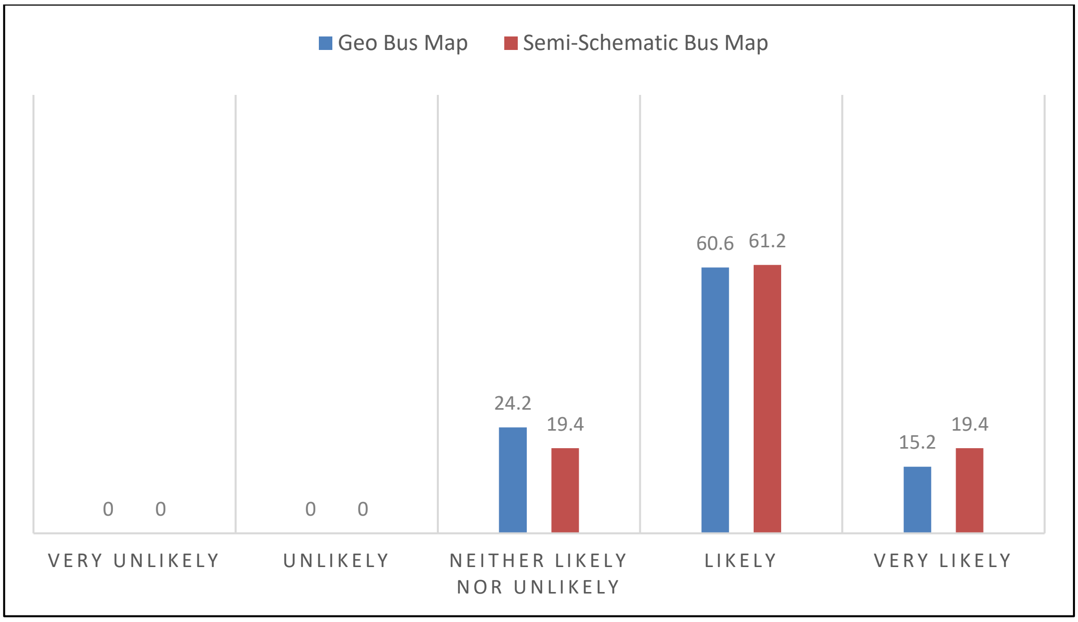

Figure 6.12: Future bus usage according to the map user preference (in percentage)

Subsequent analysis (from section 6.5.1 and section 6.5.2) further explores whether the availability of a new whole-network map continues to influence the better frequency of bus use throughout each age group and current user travel pattern.

6.5.1 Future Bus Use Potential According to Age Group

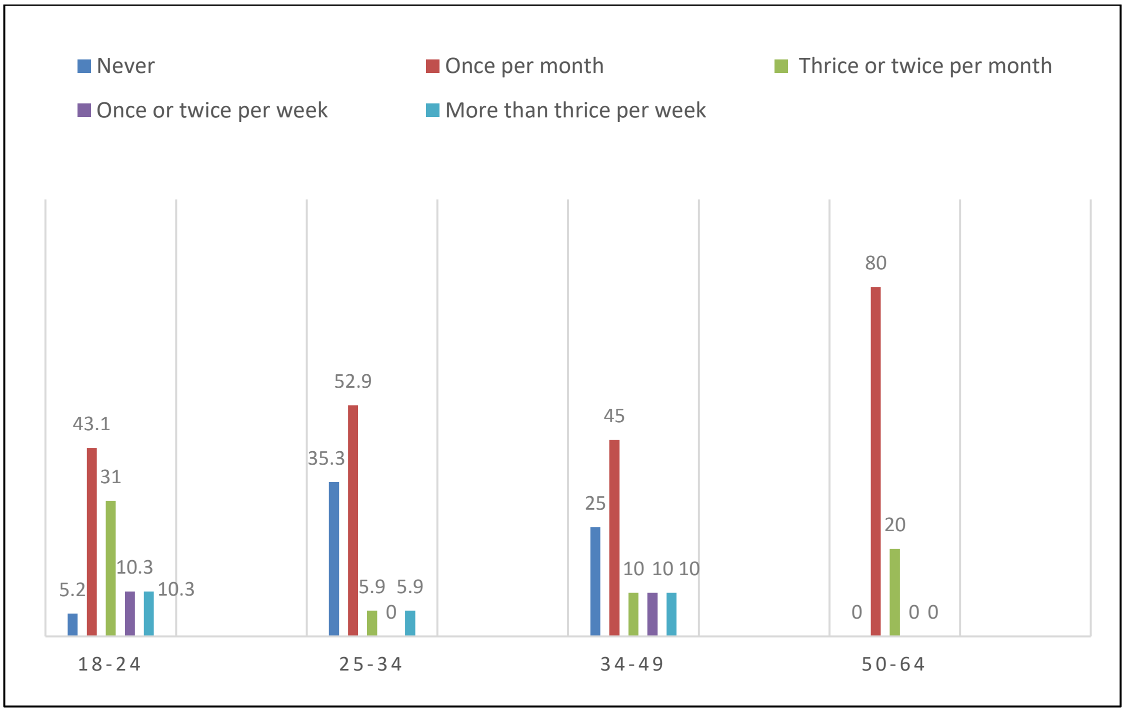

Figure 6.13: Current bus usage frequency by age group (in percentage)

Figure 6.13 shows that the current bus usage frequency is based on the respondents' age group. The highest percentage of bus use frequency in all age groups is only a one-time usage per month. Age group 25-34 and age group 34-49 recorded a high percentage of users that never use bus services. Except for age group 50-64, every age group recorded a small percentage of frequent users who use bus services more than three times per week. With very low frequent ridership across all age groups, it is interesting to see how all the age groups predicted their future bus use. Further analysis was carried out to investigate whether all the age groups would increase use after they have been exposed to the availability of a new whole-network bus map.

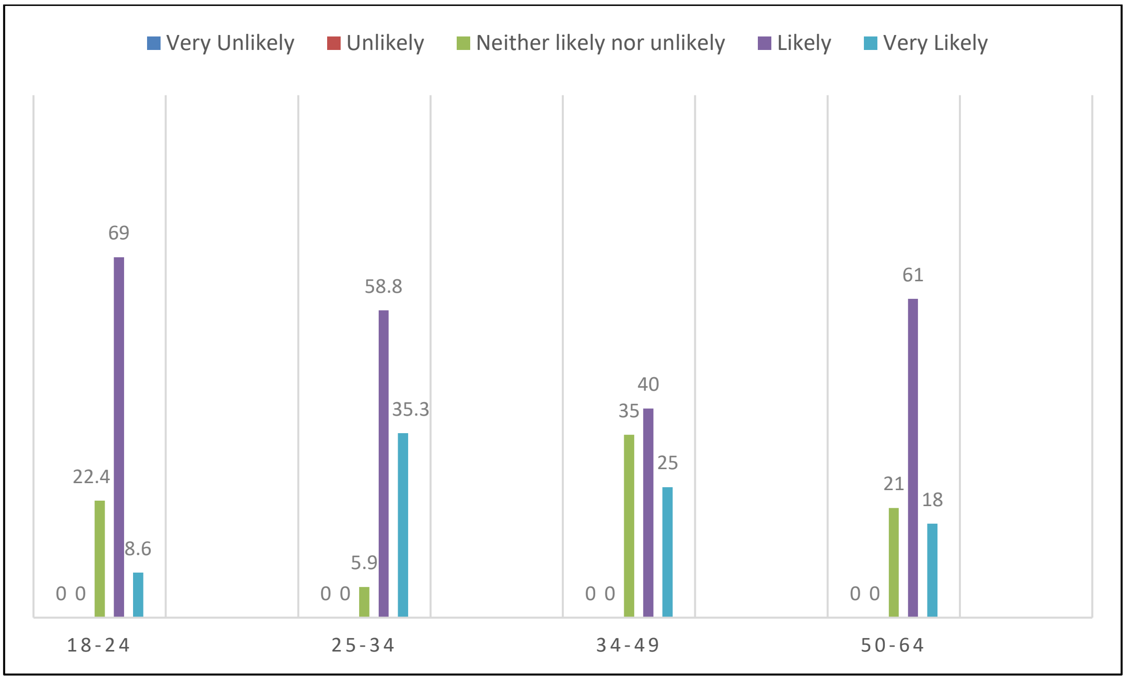

Figure 6.14: Future bus use possibility based on age group (in percentage)

Figure 6.14 shows the possible future bus usage across all age groups. All the age groups show positive future use with the highest percentage in all age groups indicating that they are likely to use the bus in the future. All the age groups have the same median score (Md = 4). The oldest group (50-64 years) have the highest mean rank (4.40), follow closely by group age 25-34 years with 4.29. This median score indicated that these age groups are the most impressed and more likely to use the bus if the maps are made available. 79% of respondents from the group age 50-64, which only use the bus not more than twice per month previously, have indicated that they are very likely or likely to use the bus more in the future.

A Kruskal-Wallis test revealed a statistically significant improvement in future bus usage rating across all four different group ages (Gp1, n= 58: 18-24yrs, Gp2, n = 17: 25-34yrs, Gp3, n=20:34-49yrs, Gp4, n=5: 50-64yrs), X^2 (3, n = 100) = 8.816, p = 0.032. This analysis indicates that all age groups would be positively impacted by the introduction of a new whole-network bus map.

6.5.2 Future Bus Use Potential According to Current Travel Choice Availability

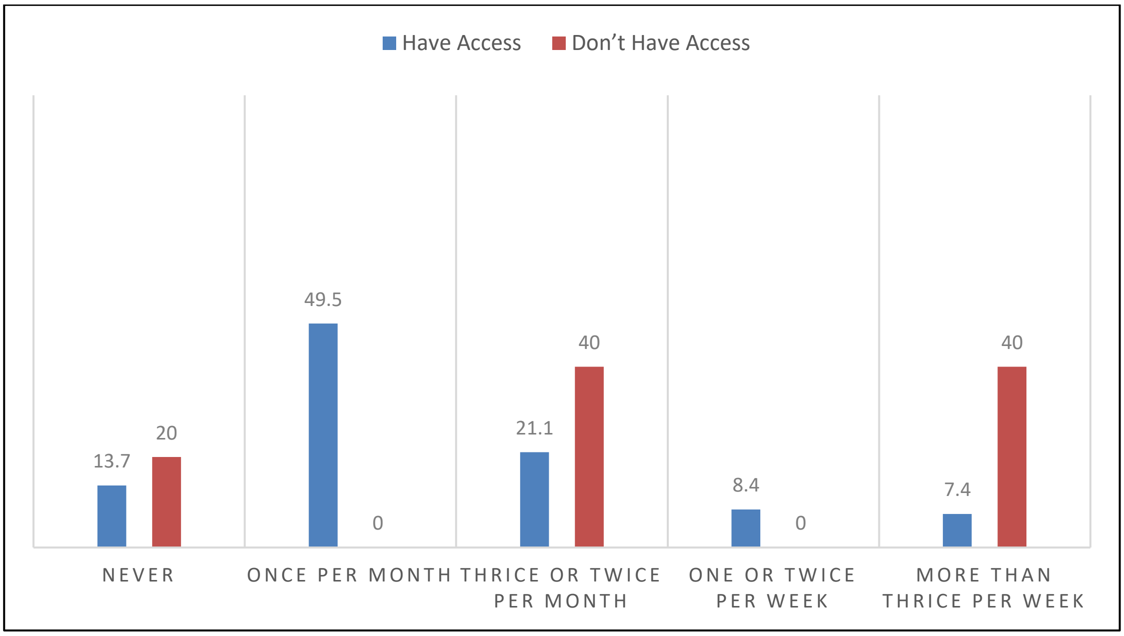

Figure 6.15: Current usage frequency of those who have access to car/motorcycle (In percentage)

The bar chart above (Figure 6.15) shows the bus use frequency based on the respondent’s accessibility to a car or motorcycle. The respondents that have access to a car/motorcycle mostly use the bus only once per month (50%). The 40% of respondents who do not have access to a car/motorcycle unsurprisingly make the bus's fullest use (more than thrice per week).

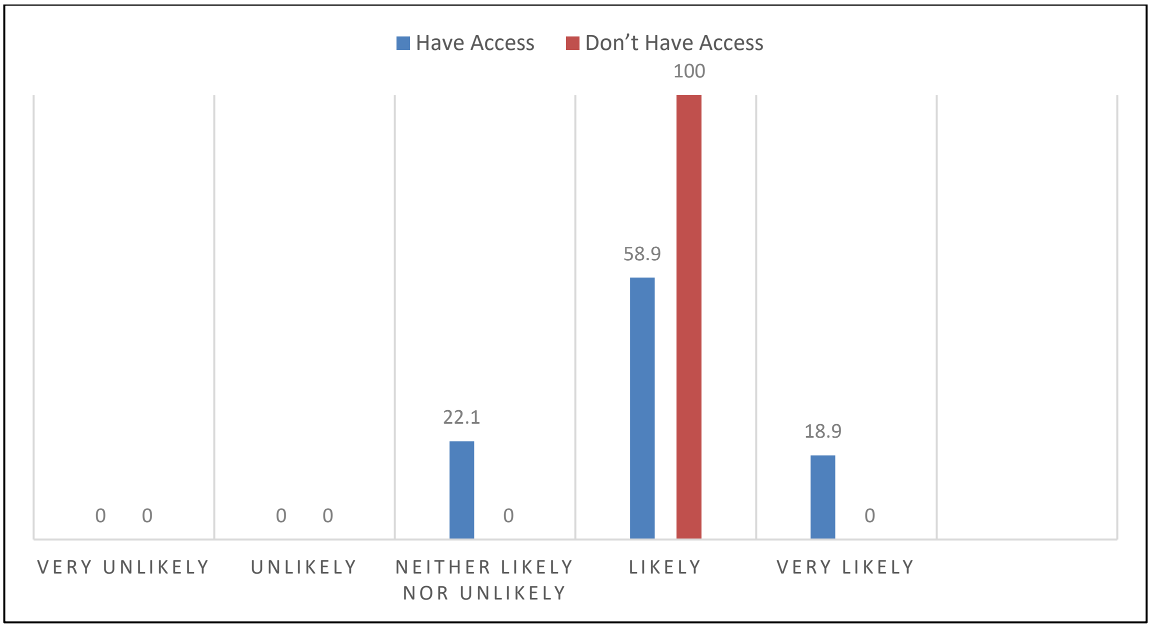

Figure 6.16: Future bus user potential based on the user that has accessibility to a car/motorcycle

Based on figure 6.16, most of the respondents (78%) react positively to the possibility of using the bus more in the future. All respondents who do not have access to a car/motorcycle have stated that they are likely to use the bus in the future. No respondent suggested that they are unlikely or doubtful to use more bus service if an appropriate map was available. However, a small percentage of 22% of the respondents have access to a car that still doubt the future use of bus services.

6.6 Landmark Placement Analysis

The final map design element measured in this study was user evaluation of the number of landmarks included on the maps. Users gave feedback on a 5-point Likert scale, where they needed to state whether there were too few or too many landmarks being placed on the map. As Figure 6.17 shows, 60% stated that the number of landmarks presented in the map was sufficient, followed by 33% that stated the landmarks were more than there should be. Only a small number of respondents thought there were not enough landmarks (2%) or too many (5%).

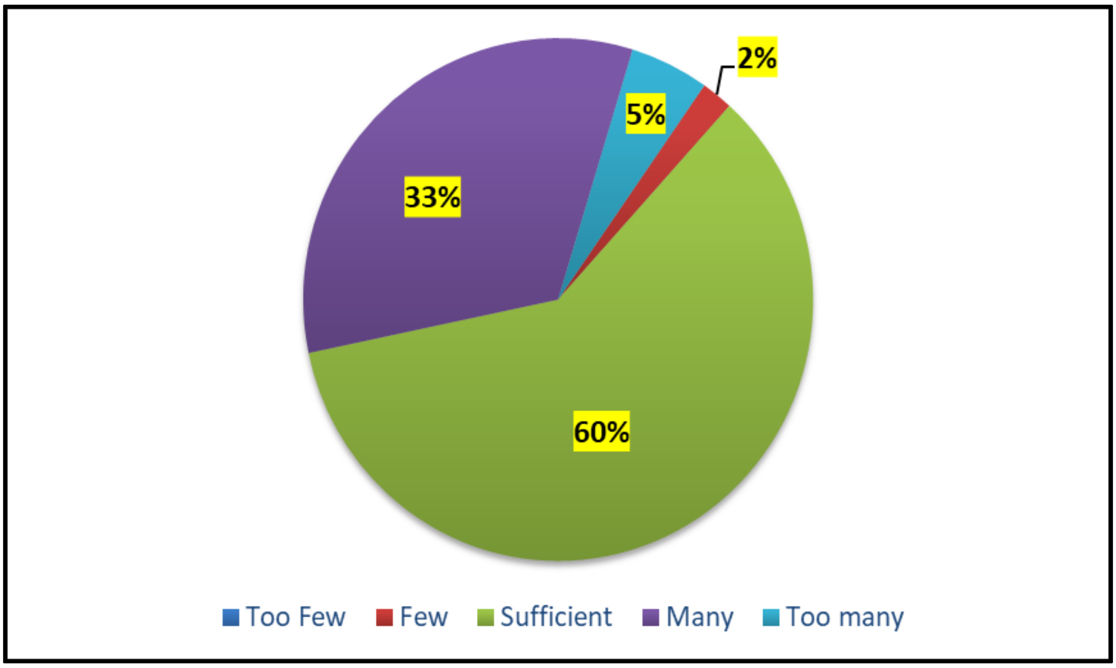

Figure 6.17: Landmark placement rating

Similar findings were found when evaluating landmarks from two critical perspectives, from the respondents who have a driving license and respondents with previous bus usage experience (Figure 6.18 and Figure 6.19). Using landmarks during their previous navigational process can help deliver another vital insight to the rating. It was found that almost half the respondents in both categories stated that the number of landmarks is sufficient (48% and 51%, respectively). Both categories also showed a similar low percentage that gave their verdict that there were too many landmarks on the map (5%).

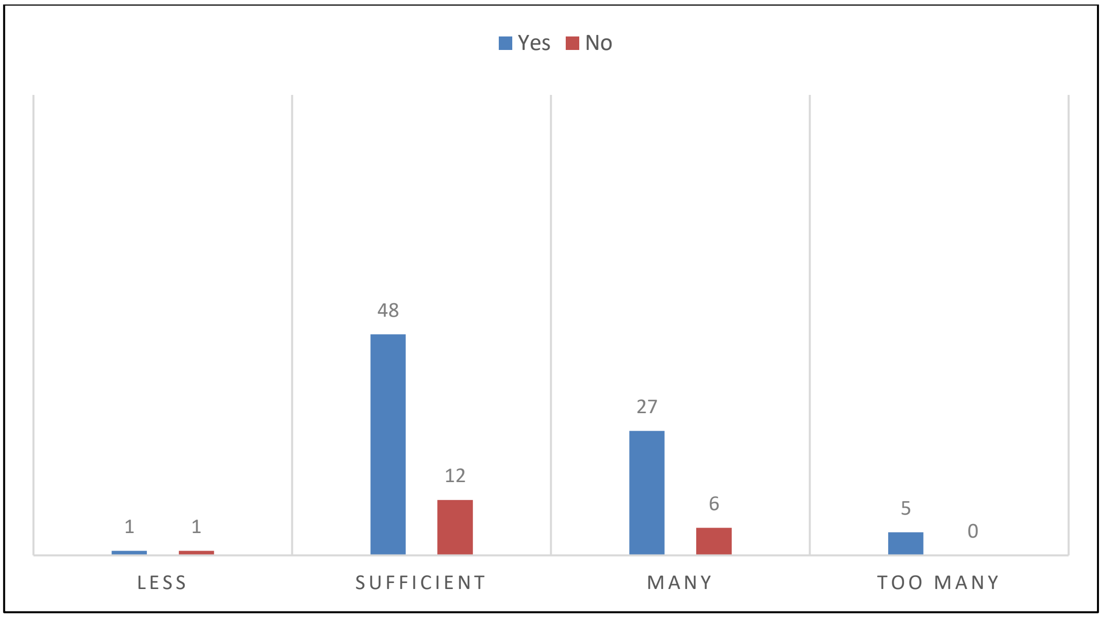

Figure 6.18: Landmark rating according to availability of driving license (in percentage)

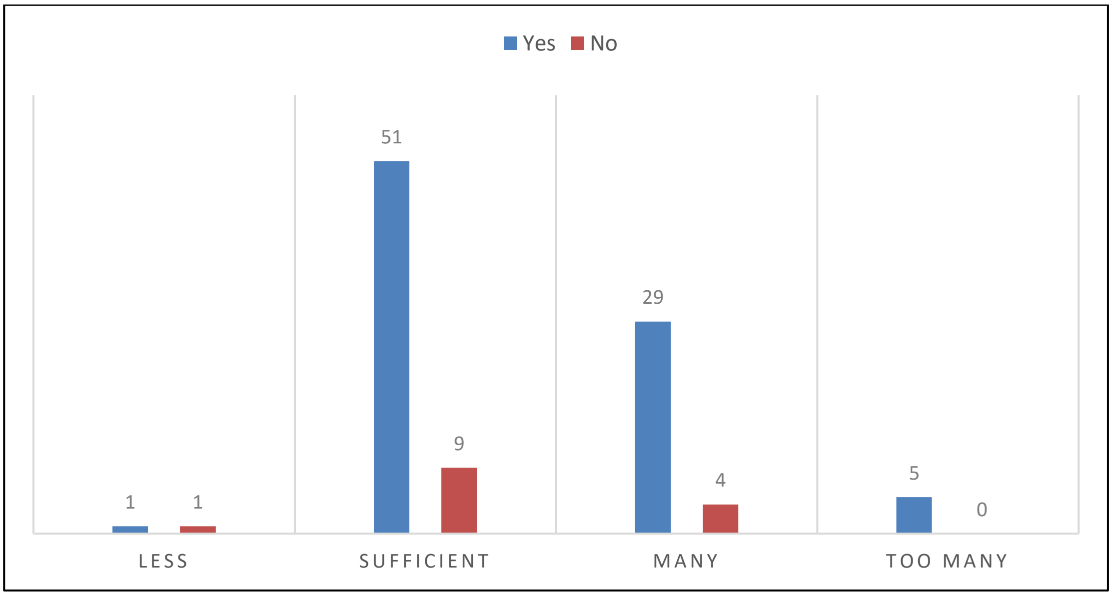

Figure 6.19: Landmark rating according to bus usage experience (in percentage)

The map design process used findings from the map review, together with several other references in determining the number of landmarks and type of symbol that should be placed on the final map prototype. A systematic placement and organisation of landmarks in a map can improve user orientation, making it easier for them to use the map and successfully plan their intended bus journey. The results support the preliminary research in determining the effective use of landmarks in bus map design.

6.7 Results and Analysis Summary

The final field test results indicate the advantage of the implementation of a whole-network bus map in effectively presenting the geospatial information of the bus transportation services to the users. The whole-network bus map design, regardless of map design format, will help the users know what services are available to them and subsequently choose the right services to complete a journey. This situation has been demonstrated in the success of their journey-planning tasks, where a high percentage of respondents managed to give a correct and optimum answer.

The level of confidence in using public transportation is a significant factor in influencing people to make more use of public transportation. The whole-network bus map creates a degree of confidence in using the bus and simultaneously visually enhances the bus services' image as something that can be easy to use. Further analysis has shown that introducing a new whole-network bus map design can entice more people to use bus services. A significant number of private vehicle owners and people who have access to a private vehicle have stated that they would be willing to use the bus more frequently should the map be made widely available. Although there is no assessment on whether respondent’s statement on the future frequency of bus use is consistent with their actual future travel attitude, these results generally suggest that the availability of additional public transport information would positively affect bus ridership. It is also important to state here that, for the bus transportation system's overall improvement, the bus network map is just one of the key developments needed to contribute towards an increase in bus usage. Other aspects of the overall bus service systems need to be improved with the information provision about the transportation system.

Even though both map designs have performed remarkably well in the journey planning tasks, one design has been singled out by the respondents as the preferred design. Respondents have pointed out that they preferred to use the bus map in Semi-schematized form, rather than the Geographical Approach bus map design. This map design preference is consistent throughout genders, age groups, and previous bus use experience. It was observed that the findings were closely influenced by the users’ confidence level and ease of use rating given after they completed the journey planning tasks.

Another prominent factor influencing this design style selection is the lack of need to refer to the inset map during the map use process. The flexibility offered by the Semi-schematized form in clearly present all the bus service information in only one map makes the map use process feel seamless when it comes to connecting the information given in the city centre with the area outside of it. Several respondents cited this reason throughout the field test.

The results and analysis presented in this chapter accentuate the benefits of having a meticulous procedure in making a new public transportation map. All the statistics shown have proved that the maps have improved both the information provision of a public transport service and the image of the public transportation service itself, resulting in enticing more users to use the service in the future. Positive comments that were flowing from many respondents have indicated the public's need for more map deliverables containing public transportation information in that area. However, to truly determine the impact of the whole-network bus map would require several research modifications.

One of the modifications that can be made is to place the maps at several main transportation terminals for a certain period before a test occurs. This modification would allow the potential and current users to get familiar with the map over time. The primary measurement would then be to monitor the change in bus ridership, to see whether there is an actual increase in patronage level and gathering the user feedback on whether they have made a correct and optimum journey after consulting the new map.

CHAPTER 7

Conclusion and Recommendation

7.1 Introduction

This chapter summarizes the findings of this research. An overview concerning the research aims and objectives, the research implications, the impacts, and the significance of this study is presented here. Finally, recommendations on possible future research are given to further improved the capability of whole-network bus maps to enhance public transportation systems and encourage its use.

7.2 Summary of Research Aims and Objectives

This thesis was created to evaluate the effectiveness of the whole-network bus map concept, a topic that is rarely visited by current cartographic and transport planning research. Four main objectives were developed as the basis of this research. The first and the second objectives were to carry out a comprehensive review of the current bus mapping and subsequently establish a view on the most favourable practice(s) for bus mapping.

In achieving the first three objectives, the first research task involved investigating current views on spatial information provision about bus transportation systems. Here, two research phases were completed, starting with a thorough literature review covering the broad aspect and the significance of public transport information provision (Chapter 1 and Chapter 2). This review also discussed several notable published map design guidelines that significantly impacted this study.

A systematic review and analysis of published bus maps was subsequently conducted. The review involved an examination of current bus mapping diversity through a wide range of published bus maps. This process's output can be found in Chapter 3, where each essential cartographic design aspect of bus maps was investigated. This review became the basis of the map design processes used to create two whole-network bus maps. The two whole-network bus map prototypes were then used as the primary research materials in field map testing.

The fourth and the fifth objective was to assess how effective the prototype bus maps are in assisting public transport users in planning bus journeys. This task involved the preparation and the delivery of an experimental research design. The experimental design evolved around the map usability test concept. The usability test approach ensured that the results gathered are unbiased and focused on evaluating the maps rather than the participants. This test focused on determining whether a new whole-network bus map could effectively help customers in using public transport systems. The usability test also helps to discover which of the maps the respondents preferred to use. The test's evaluation was centred around three factors: map effectiveness, ease of use, confidence level while using the map, and map satisfaction rating.

The map usability test (Chapter 5) has shown that the whole-network map, regardless of map format, does bring significant support in aiding the user to make efficient journey-planning decisions. Statistical tests were performed on the data to verify any association between respondents' journey-planning task score, respondents' rating on the ease of use and confidence level after each map has been used, the respondents' preferred map format, the respondents' future travel behaviour, and the respondents' demographic background. Conclusively, the Semi-schematized bus map design holds a modest advantage over the Geographical-Approach bus map design in terms of user preferences. The map design preferences were consistent throughout all the users' demographic factors. The Semi-schematized design also gained the best results in the journey planning task's correctness, ease of use rating and confidence level rating.

The final objective is to provide recommendations for the production and distribution of maps and how this can be integrated into other public transport information delivered in this chapter. The recommendations given are based on the analysis and findings that were presented in Chapter 6. In general, the results have indicated that the whole-network bus map can increase bus ridership and greatly enhance the image of the bus transportation system in the study area.

7.3 The Significance of Findings

The significant findings of this research can be seen in four different areas. The four different areas are the improvement of bus information provision in the local area, the creation of efficient bus mapping criteria, the development of the exploratory experimental research in any new area, and the advantage of using a whole-network bus map in improving bus transportation services.

7.3.1 Improvement of Bus Information Provision in Local Area

The review of Malaysia's current urban transportation situation (Chapter 1) suggests a great need to improve public transport information provision. The improvement of public transport systems in Malaysia has focused on the physical infrastructure, where building better bus terminals and providing more modern buses were prioritized. However, as the ridership did not increase as expected, the authorities now realise that persuading users to use public transport goes beyond infrastructure improvement. Users need to be well informed about the whole bus service network available for them to use.

The lack of useful bus information was exemplified in many situations within the study area. A whole-network map can only be found at the main terminal bus station. The map is in the schematized format. It has been placed on the information wall since the start of the bus transformation program back in 2013. As such, the information on the map is obsolete as. no update has been made since 2013, despite the continuous changes to the bus services routes.

The lack of useful bus service information was not only limited to the bus users; it is also affected by the management of the bus service provision in the local area. The bus company does have a world-class bus management system. Their intelligent bus management system was supplied by GMV, a smart transportation technology company from Spain. Every bus has a GPS unit, and all the live information about the bus position is made available to the public via LCD screens in buses and at several bus stops. However, the information is only presented in text form. No maps are used to spatially-present the digital information.

7.3.2 Efficient Bus Mapping and Transport Information Elements

Chapter 2 presents a wide-ranging review of public transport information provision. The review highlights the quality of information needed in the user's eyes, the operators, and the public authorities. Understanding the mapping needs of these three main stakeholders in the public transport industry is the key to delivering an effective map product. Each stakeholder has different requirements and demands, but everyone agrees that proper information provision is essential in elevating user confidence in using public transport. Having the right confidence level will entice the users to make more public transport journeys, provide more income to the bus operators, and ease the authorities' transit management.

Further reviews on the cognitive mapping aspect and the people’s ability to use public transport maps have recognized the prerequisite conditions that must be considered while making a new map. Knowing the user's limitations in comprehending mapping information and appreciating their actual ability while using public transport information provides a genuinely efficient map product. It is interesting to validate the importance of landmarks in easing the map use process. Landmarks give vital information that can enhance the user's recognition ability and self-location ability, provided that the landmarks were presented appropriately.

The subsequent map review analysis – through the use of content analysis method – represents a comprehensive classification of the diversity of bus map design. Here, the resulting map design analysis outlines several consistent map content and map design criteria preferred by most of the map makers. Specific landmark analysis was done to investigate the level of landmark presence in existing maps. All these findings from both chapters have helped identify the considerations when designing the final field test's bus maps.

Among the benefit of using content analysis is replicability. Content analysis is already a proven analysis method in other fields of study. This study has shown that there should not be any problem for this method to be practised effectively for other map analysis. Further studies can use the map evaluation form developed in this study to understand why particular cartographic decisions were made within other types of map design. This map evaluation form can be used with other qualitative approaches to make it more effective. It is hoped that providing the evaluation form will spur more research into the development of public transportation maps, which is often neglected in cartographic research. The template of this map evaluation form can be found in Appendix C.

7.3.3 Performing Exploratory Experimental Map Design Research

A relatively small number of previous studies investigate the impacts of mapping information in Malaysia, where the research on this domain is minimal. Previous studies in Malaysia have looked into different aspects of transportation services that cause low ridership, for example, the lack of infrastructure (National Land Public Transport Commission (SPAD), 2012), the bureaucratic problem (Azmi and Nor Fanim, 2012), and the human and environmental factors (Zakaria *et al.*, 2010). No study has been made on the impact of adequate mapping provision in enhancing bus ridership. A different methodological framework and field test procedures were needed to complete the research effectively and met all the objectives.

A new conceptual framework was created, which is based on the User-Centred Design (UCD) theory. Chapter Four has elaborated this conceptual framework methodology in detail. A map usability test is an integral part of this study and was included as one of the framework's phases. Based on the results and analysis of the findings, the test has been proved successful evaluating the map design. Since this is exploratory research, several differences were applied in the data collection procedure, sampling technique, and data analysis techniques. Performing the map usability test at open areas (bus station, bus stop or bus stance) proved challenging due to the study area's research culture norm and local stigma. Thus, it was decided that the sampling procedure should use the purposive sampling technique to gain more respondents and gather more reliable responses. Chapter Six outlined the statistical techniques used to interpret and analyse the collected data. As this research is exploratory, the non-parametric statistical test was selected to be used as the primary statistical test tool. It is hoped that by depicting the methodological and analytical process in a step-by-step aspect, other researchers can apply it in their research, which will ultimately spur more map use and usability research activities.

7.3.4 Key Findings from The Field Test

In general, the field test results demonstrated that there were significant needs for a whole-network bus map of the research area. Both maps have received a useful review, and, in some cases, the maps were an eye-opener for people to know the bus provider in their area provides the current system. Both maps have improved the respondent's knowledge of the bus services in their area and allowed them to perform a query on the journey planning task correctly and quickly, as proven by their answers in the questionnaire form.

One of the main objectives of this study is to increase bus usage through maps and based on the finding of the final field test, there appears to be a positive attitude to this. The maps have instilled a confidence level among respondents towards the bus service system. Many respondents stated that they would consider using the bus more frequently if they were supplied with more information about all service routes in their area. The results also indicate that respondents who have regular access to the car could also like to use the bus service more frequently after the testing.

Overall, respondents preferred using the bus map in Semi-schematized map design rather than the Geographical approach map design. Among the reasons for this choice is that they can view all the bus routes and make decisions by looking at one map only. They do not need to focus on or refer to the inset map as in the case when they did the test using the Geographical Approach map. However, some respondents, especially from the older generation, prefer the Geographical Approach bus map. They are more accustomed to the area's geographical landscape and do not like any alteration being made to portray the geography of the area.

There were some interesting findings when the researcher conducted testing at the bus provider office - RapidKuantan Pte. Ltd. The bus company has a world-class bus management system. Every bus has a GPS unit, and all the live information and status about the bus is made available to the public (including live timing) via a digital screen placed in the bus (Figure 5.6) and at several prominent bus stop locations (Figure 5.7).

Figure 7.1: Live information shown in bus

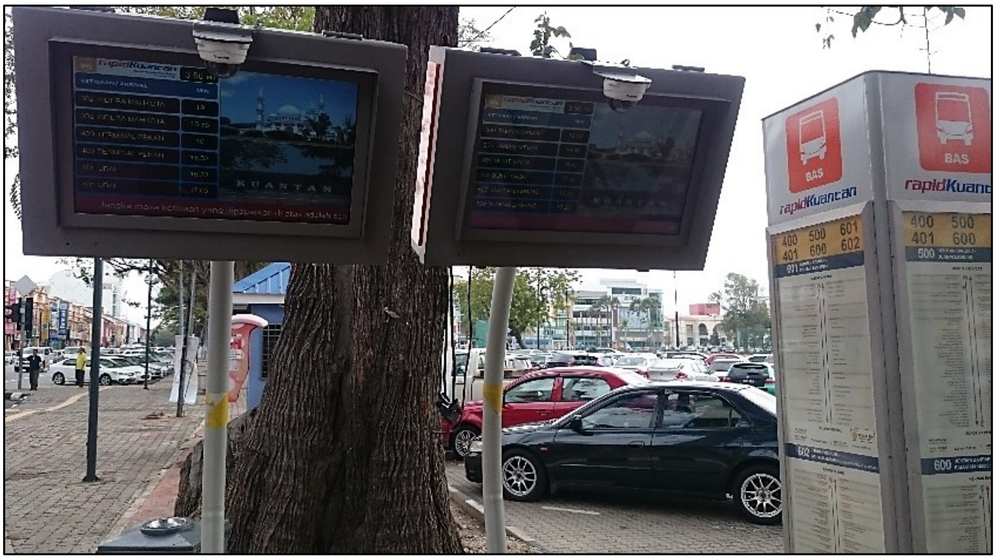

Figure 7.2: Information screen located at a bus stop

The lack of map development in the company can be related to the company structure. It was found they do not have a cartographic department or cartographer in their ranks, and no recent contacts were made with any cartographic-based contractor. The task of making maps is solely by their IT department workers based on their limited ability and knowledge. This situation certainly explains why there is a lack of good bus maps being made available, not just for the user but also for other stakeholders involved in this industry. As stated in Chapter 1, the only map made widely available to the public is in the form of thermometer design maps, a map containing one arrow pointing upward and one arrow pointing downward with a list of destinations being placed alongside the arrows. A full network bus map in the form of a schematic design can only be found at one bus terminal, which has not been updated since 2012. One of the senior management staff was impressed with the new bus maps and quickly suggested that the map be made available to the public and to all their staff to ease their bus management system in the office. According to him, the map could help them understand the current service area of all their buses and make it easier for them to delegate a location-based task among their workers. Further engagement is expected between the bus company and the researcher to improve the bus information provision for the City of Kuantan.

This feedback adds to the positive feedback that the researcher received during the field test process, highlighting the importance of this research in improving bus information provision. Further work and further networking are expected between the bus company and the researcher to realize the required improvements. This further work includes more cartographic research projects involving implementing useful transit information at every stage of passenger engagement. Further research will focus on the network map and good cartographic design for bus stop signage, onboard system map, trailblazer signage, and useful timetables design. Moreover, the bus company expects this study's findings and output to be simulated in bus services operated by them in other cities, namely – Penang, Manjung, Kamunting, Subang, and Kota Kinabalu.

7.3.5 Use of Whole-network Maps in Improving Bus Transportation Services

The results and analysis of the map usability test (Chapter 6) have clearly shown the benefit of having a whole-network map in improving the user journey planning experience, regardless of the map format. The high number of correct and optimum answers in the journey-planning task justifies the assumption that providing people with relevant information at specific points of public transport use can enhance their decision-making skills and reduce the cognitive load required during the journey-planning process.

Furthermore, the high scores in confidence in using the bus maps and the strong potential for future bus use have highlighted the positive impacts of introducing a new whole-network map in the study area. Improved mapping material will enhance the overall image of public transportation services. All the relevant stakeholders should focus on this type of information, including incorporated these maps as part of the extensive public transport information provision.

7.4 Research Limitations

Although careful consideration has been made in all methods and research approaches, the method selected to be used in this study still has limitations that need to be acknowledged and explained.

7.4.1 Sampling Technique

Obtaining a sample representing the general transportation user profile was prioritized; however, it was challenging to gather the desired respondents based on that profile during the final field test. During this study, the experience is similar to the experiences found in the previous studies where the transportation hub environment cannot provide a conducive place for conducting public transport information research (Evans, 2010). This situation was first experienced during the pilot test, which instantly flagged the need to find alternative data collection techniques for the final field testing.

The main issue that needs to be resolved here is testing in the intended usage environment. Testing at a public transportation hub (bus stance, bus stop, and bus terminal) would provide an actual environment, but consideration needs to be made in gathering a suitable and sufficient response from the respondent. Conducting public participatory research in an open area was also difficult to achieve due to cultural acceptance in the study area. The interception method failed to find a good number of willing respondents, or should the researcher manage to find a willing respondent, and the feedback given was not of good quality (blank spaces and wrong answers). The approach was changed to pre-arranging the time and place for the willing respondent to conduct the test. This approach proved successful as the researcher managed to gather the required sample of respondents that reflected the general public user-profiles and achieved a quality response on the test form at the same time.

The field test was designed as exploratory research to test the effectiveness of map design elements in a printed bus map in the study area. Recording the time taken for a respondent to finish the task was not feasible due to several stigmas. This stigma has prevented the time taken for a respondent to complete the test to be included in the analysis. Many respondents quickly turned down the request to participate once they knew their test time would be recorded as they thought the test was being done to expose their intelligence level. As for the willing respondents, although a lengthy description of time efficiency was given before the start of the test, the majority of respondents did not fully comprehend the importance of the time recording.

Several of them were intrigued by this kind of research as it was their inaugural experience in performing such a test, resulting in time-wasting incidents caused by questions unrelated to the focus of the task. Some other respondents did not quite understand the technical instruction given, which resulted in additional questions being asked during the test time. This situation is understandable since this research is exploratory. However, these issues have not affected overall the outcome of this research. Several of these issues were expected earlier, and several issues were resolved during the pilot study. Thus, several alterations were applied to the research methodology and research data analysis to ensure integrity and deliverability of the data collected.

7.4.2 The Physical Size of the Whole-network Bus Map Design

The map design process chose to use an A2-sized design based on two reasons. The first reason is to incorporate all the crucial mapping information and elements in one single space, and the second reason is based on the findings gathered from the map review analysis where most of the whole-network maps were presented in the large-sized paper (A3 or larger). However, there is limited space available at certain bus stances or bus stops, as not every bus stop has enough space to display an A2-sized whole-network map. This situation is particularly the case at bus stops that do not have a shelter, where there is only a pole with bus stop signage mark the bus stop location.

Decreasing the whole-network bus map's physical size would directly impact several key map elements and information. These elements include the general map scale and the bus service network's overall area extension, especially if the city's size is enormous. Decreasing the size would also affect the amount of non-service information essential to a bus map, such as the legend information, additional road network, and landscape features, and landmark placement.

The most critical effect of this map size reduction would be the map representation's effectiveness as there would be a need to compromise in the placement of every essential map element to preserve the legibility’s acceptance level.

7.5 Recommendation: Research Implementation

The whole study was designed to understand the current issues surrounding public transport information material, understand the essential criteria of an effective bus map design, design a new whole-network bus map, and subsequently test the map. Besides meeting the study's objectives, the whole process highlighted transit literacy among the test respondents. Transit literacy can be defined as the competency in using public transport information to make a compelling public transport journey, even without any previous public transport experience (Hardin, Tucker and Callejas, 2001). In general, the respondents' level of transit literacy after they completed the test was quite good.

However, as data in chapter 6 shows, respondents started to have difficulty in completing medium and complex journey planning tasks (requiring transfer of bus services). This situation shows that the knowledge about public transport journey planning is not independent. Even though all respondents were given the same information, the difference in scores means a gap in transit literacy level between respondents. The following paragraph's specific recommendations are made based on the above transit literacy condition, together with the results and analysis gathered in this study.

7.5.1 Put More Emphasis on the Service Transfer Points

An examination of the bus network in the City of Kuantan suggested changing from one bus route to another bus route is essential for many bus users in Kuantan. The geographic layout of bus service networks in the City of Kuantan requires the users to make one change of service should they need to complete a trip through the city centre. Although the main transfer points have been highlighted in the two-prototype whole-network map, several users still had a problem in identifying them. Additional intuitive remarks or descriptive information needs to be added on the map to assist users in how to complete the bus transfer, should the need arise. The remark should then be made consistently throughout all maps and other promotional products to avoid any confusion. A similar remark should also be placed on the ground (signage at the bus station/bus stop) to ease the users' cognitive process. Research has shown that map design can influence user behaviour in choosing interchange locations (Roberts and Rose, 2016; Morgagni and Grison, 2019).

7.5.2 Provide Consistent Passenger Information Material Throughout the Service Chain

Effective public transport information material can help passengers plan an accurate public transport journey and make an informed decision. As this study manages to highlight, informative material effectively helped users in making a correct journey-planning decision. This study's findings should be used as a justification for further information material to be provided by the transport agency. Several respondents have cited that among the reason that they were unable to make a correct trip plan is because of the different types of information material provided to them. They were confused and frustrated with different types and levels of information provided by the agency at each travel point.

For example, the mapping information that they found on the agency's website was totally different from what they found at the bus stop and on the bus. The information was not the same, but differences in the design of mapping elements (route colour, background information, point of interest) have also made the situation even more complicated when comparing the information from one source to the other. The adoption of consistently practiced information design (symbology, visual variables) will enhance the information materials' intuitiveness and ease the usage process as the same cues are provided to the users at each travel point. The design uniformity of information materials should then go beyond the city-wide to state-wide, or even to nation-wide – thus creating a unique style that can evolve as an identity of one place.

7.5.3 Future Dissemination of Whole-network Bus Maps

The whole-network bus maps designed in this study are only intended and convenient for use at the public transportation hub, such as bus terminal, bus stop, or other physical transport infrastructure. The large size of maps and the extensive mapping area made the usage ideal for the places mentioned above. The whole-network map's primary purpose is always to provide an overview of all bus services available for the user, which is an aspect that many electronic devices fail to provide. However, there is an essential need to increase the maps' mobility factor, which can ease the map dissemination process to the target users. Selecting a proper map folding technique can effectively reduce a large sheet of paper to a pocket-size product, simultaneously bringing a significant upgrade in terms of the large-scale map product's mobility factor. Various folding schemes are possible, but analysis of these is beyond the scope of this study.

On the other hand, with the recent technological advancements, the whole-network bus map can utilise the technology in providing an inventive way of displaying the maps to the public transport user. The digital copy of the whole-network bus map should be made available on websites operated by the bus provider and the authorities. From the website, the user should have the option to view the map directly online or an option to download a digital copy of the map. Both options have their practical advantage that can cater to every user's specific needs. Some users would like to have the ability to view it online to avoid downloading any material that can affect their device storage. However, this kind of information dissemination needs to be accompanied by a good 'map player' on the website that enables the user to experience an effortless map use experience. The zooming function should be prioritized in terms of effectiveness as most devices, especially the mobile ones, have minimal screen space.

Moreover, the map's downloadable option would enable the user to use the map at any time and any place, without the worry of poor telecommunication coverage or high internet data consumption should they repeatedly use the map over time. Users can use the map at every traveling point with the ability to print out the downloadable map. They can start using the map at home or office before they embark on any bus journey, or they can use it instantly if they needed any additional information or reassurance during their trip.

It is best to suggest that the whole-network maps' availability needs to be publicised widely through the respective authority's social media arm (Facebook, Instagram, Twitter). Placing the whole-network map on the social media instrument might not be viable in terms of map use effectiveness, but promoting and informing the users about the maps' availability can be done through that instrument. The transport provider and the authorities should ensure that the users know where the whole-network map can be found.

This is not to suggest that the whole-network map is more important than an effective journey planning application (app), but should be seen as complementary, with a focus on conveying the availability and extent of the public transport network, and promoting its use by planting a seed that a journey by public transport is feasible.

7.6 Recommendation: Future Research

7.6.1 Expanded Map Design Analysis and Testing of Whole-Network Bus Map

This study has shown that the whole-network concept does bring several benefits and can improve the bus transportation system's information provision. Further map testing research involving more respondents from various demographic backgrounds and a broader network area should be prioritized to get more data and feedback, further improving the current bus map design. The research could be expanded to other neighbouring cities that share similar demographic and cultural characteristics to intensify this research's impacts, simultaneously bringing much-needed improvement in public transport information provision in the country.

Additionally, the element of time should be recorded during the journey-planning test to enable additional statistical data analysis, leading to an improved understanding of the implemented map design's effectiveness. To understand the perceptual and cognitive processes involved in using the maps and complete the tasks, eye-tracking could provide information about what users look at while performing tasks.

It is proposed that this further research be conducted in controlled laboratory conditions, but with an added simulation that can replicate the real public transport hub situation. Among the simulations that can be added is creating a full-scale bus stop model, with the mock-up creation of every bus stop element. Adopting other user-engaging techniques, such as the immersive video technique explored by Weihong-Guo, Blythe, Olivier, Singh, & Nam Ha, (2008) in their research, can help provide a better real-life simulation to the users. In this technique, each key location involved in public transportation usage was projected to large display screens. Additional surround sound technologies were added in the scene to elevate the actual users' visual and audio experience of the real environment. Although this controlled test was still conducted in a laboratory environment, this move could reduce the gap to the normal use situation and provide more quality feedback from the respondent. This kind of technique provides an encouraging method for future research in the map use and map usability domain.

7.6.2 Automated Map Design System

The manual process of producing the whole-network bus map designs for this study was guided by the map review process with several other map design guidelines. The manual process of the map design consumed significant time and resources. This process is one of the barriers that prevent the process from being looked upon as one of the cost-effective solutions to improve the information provision, especially if this process needs to be expanded to other major cities around the country. An automated map design system that can speed up the whole-network map design process would be significant step forward in this domain.

A substantial amount of research focuses on automated transit map design, but the majority focuses on automated design for a full-schematic map. It is not surprising that most of the previous research focuses on the schematic design as this type of representation puts more emphasises on the generalisation of the network topology rather than maintaining the right geographic shape with the network location – making it easier to manipulate the data without the need to adhere to any natural spatial rules. These processes have proved useful in automating schematic maps, which resulted in generating an appealing schematic map in a rapid time (Ware, Taylor and Thomas, 2010; Ribeiro, Rijo and Leal, 2012). However, it is noted that a full schematized representation is not the most suitable design form for a bus route network map (Morrison, 1996b).

Thus, it will be crucial to consider the potential of this type of research in this domain, to examine how the findings and the analysis regarding the schematic development can be integrated for the automated production of the Semi-schematized whole-network bus map. The future research in this domain could commence using ArcGIS Schematics, an extension for the ArcMap and ArcGIS Enterprise. According to Esri, this extension permits the map makers to simplify a network's representation, with the objectives to clarify their structure and make users understand the background of any operation (Esri, 2019). The extension's strengths include the ability to automatically generate, visualize and manipulate diagrams from spatial data or data with attributes of connectivity. This ability means that this extension could allow schematic representation and other types of representation – namely geographic or semi-schematic, which are the most suitable map design forms for a whole-network bus map.

Apart from developing a fully automated map design process, further research could enhance a semi-automated process. A semi-automated map design combines an automated system, provided by geospatial software and mathematical algorithms, with human assistance in some steps of the map design process. Not all map design processes can be efficiently automated mostly in terms of effective selection of symbolization and other visual variables, which cannot be provided by most cartographic software (Avelar, 2008; Tsorlini *et al.*, 2017).

Beyond technological developments, this study has exemplified the benefit of cultural considerations and understanding local customary values when choosing the type of symbolization to represent landmarks. Respondents have given good feedback on the symbolization used and stated that the selection did enhance the overall map use experience. Thus, this research's natural advancement would be further research in the development of semi-automated mapping design and system, incorporating the modern automated map design system with the practical sense in the map's visual variable selection.

7.7 Closing Remarks

This thesis started with presenting several issues surrounding the public transport system, both globally and in Malaysia, specifically. The population's continued reliance on private vehicles harms the development and sustainability of public transportation systems. Serious action needs to be taken to entice more people to use public transportation. Influencing people to reduce car use and make more public transport use goes beyond improving the public transportation service itself. The private car is the primary source of traffic congestion. As the congestion levels increase, the air quality level moves in the other direction and will continue to plummet in the long run. This situation will bring significant environmental problems, which could provide more severe problems than any political conflicts. While a move to electric vehicles may reduce the impact on air quality, it will not solve the problem of congestion.

Influencing people to make more use of public transport could come in many ways. One solution is to improve the provision of public transport information, with transport maps situated right in the middle of the provision. This research has shown that should people want to trade their private vehicle use for buses, they need to be supplied with adequate information on the options available. Mapping is the perfect medium to portray this information, providing information about what services are available in the area and the extent of bus services. The information needs to be presented clearly and distinctively, which could help gain user confidence while using the maps. The whole-network map concept has demonstrated that the full bus network information in an area can be effectively shown in a single map, providing the users with a full overview of all the information needed conveniently at an appropriate scale. The final field test results showed that the whole-network map brought significant enhancement in helping users make the optimum journey-planning decision. The overall results were positive, in terms of the percentage of correct answers, the level of confidence in choosing the answer, the map's ease of use, and the future usage of bus service.

On that account, it can be said that the comprehensive information provided by the whole-network bus maps produced in this research can effectively improve the provision of bus information, enhancing the bus usage experience and, ultimately, make the bus system look a complete yet straightforward service system.

7.8 List of Publications

The following are the publications arising from this thesis.

1. Mohd Said, M. S., and Forrest, D. (2018) 'Classifying the Diversity of Bus Mapping Systems', Proceedings of the ICA, pp. 1–7.DOI: 10.5194/ica-proc-1-78-2018.
2. Mohd Said, M. S., and Forrest, D. (2018) 'User Preferences for Bus Map Design: Evidence from a Map Usability Study,' Proceedings of the ICA, pp. 1–6. DOI: 10.5194/ica-proc-2-88-2019

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APPENDICES

Appendix A: Ethical Approval

Appendix B: Participant Questionnaire Form

Appendix C: Map Evaluation Form

Appendix D: Map Evaluation Form (55 Bus Maps)

Appendix E: The Whole-Network Bus Maps Prototypes

Appendix A: Ethical Approval

University of Glasgow | College of Science & Engineering

Dr. Christoph Scheepers
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University of
Glasgow 58 Hillhead
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Christoph.Scheepers@glasgow.ac.uk

Glasgow, August 1, 2017

Ethical approval for:

Application Number: 300160178

Project Title: The Cartographic Analysis on the Development and Application of Whole-Network Bus Map

Lead Researcher: Dr David Forrest

This is to confirm that the above application has been reviewed by the College of Science and Engineering Ethics Committee and **approved.** Please refer to the collated reviews on the system for additional comments, if any. Good luck with your research.

Sincerely,

Dr Christoph Scheepers

Dr Christoph Scheepers

Ethics Officer

College of Science and Engineering University of Glasgow

PARTICIPANT INFORMATION SHEET

Research study:

Cartographic Analysis on Application and Development of Whole-Network Bus Map

You are invited to take part in a research study taking place as part of educational qualification. The project is being carried out by researchers at the University of Glasgow (PhD in Geographical and Earth Sciences) involving Mr. Mohd Shahmy Bin Mohd Said (student/researcher) and Dr David Forrest (Supervisor).

Before you decide to take part, it is essential for you to to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Ask us if there is anything that is not clear if you would like more information.

1. **What is the purpose of the study?**

We want to find out whether a new version of whole-network bus map can eradicate bus user's confusion during the journey planning process. We also want to find out if this new version of whole-network map can influence more users to use public transport.

2. **Who is conducting the research?**

This study is being carried out by researchers from the University of Glasgow.

3. **Where will the study take place?**

The study will take place at several public places in city of Kuantan.

4. **What will happen to me if I take part?**

You are required to complete a questionnaire form and perform two journey planning tasks based on two design of bus map. Your performance in carrying out the planning tasks will be recorded. There is no time limit, but the time taken to complete the task will be recorded.

5. **Procedure of Study**

You will be contacted either through communication media (via call / text message / email) or verbally by the researcher and will be given the participant information sheet. If you decided to participate in the study, you need to tell the researcher about your availability date and time.

At the time of the study, you will be given a brief introduction by the research and asked to sign a consent form. You may withdraw from the study at any time.

The researcher then will give you a questionnaire form. You will only start to fill the form when you are ready. You need to fill the Section A of the questionnaire first and notify the researcher when you have done so. Next, the researcher will provide you with the first map design and you can start to complete the Task 1, and then subsequent tasks. After you have finished the tasks, Section C of the questionnaire form will be completed.

You can have break between tasks. You will be informed about any picture that will be taking and any audio to be recorded.

6. Do I have to take part?

No, taking part is voluntary. It is up to you to decide. You may also withdraw from the study at any point if you wish. If you withdraw during the study, you will be asked if you are happy for any information you have given to be used in the research. If you decline, then no information which you have given will be used in the study.

7. What happens to the information collected?

You will not be personally identified. Any of your personal information will always be stay confidential and known only to the research team. All the data and information gathered will be kept within a locked-briefcase (in research area) and within a locked filing cabinet at the University of Glasgow. Subsequently, all the softcopy or electronic data will be password secured on the researcher's computer. At the start of this research, you have been given an ID and you will only be known by that ID number. This will make it impossible to identify any participant in any published material. You always have the option to withdraw from this study at any point.

8. What if I have any further questions or complaints about any aspect of the study?

If you have any enquiries or you feel uncomfortable about any aspects of this study, you are more than welcome to directly contact the researcher. Please do this in the first instance if you have any questions.

9. Contact details

Researcher : Mohd Shahmy Bin Mohd Said
Term address : No 4, Lorong 13, Taman Seri Inderapura, 25320 Kuantan, Pahang.
Office address : School of Geographical and Earth Sciences, East Quadrangle, University of Glasgow, Glasgow G13 1DL
Phone Number : +6019-7508861 /
Email : / mohdshahmy@gmail.com

PhD Supervisor : Dr David Forrest
Office address : School of Geographical and Earth Sciences, East Quadrangle, University of Glasgow, Glasgow G13 1DL
Phone Number : +44 1413305401
E-mail : david.forrest@glasgow.ac.uk

THANK YOU SO MUCH FOR TAKING PART IN THIS STUDY!

University of Glasgow | College of Science & Engineering

CONSENT FORM

Title of Project:

Cartographic Analysis on Application and Development of Whole-Network Bus Map

Name of Researcher(s):

Mohd Shahmy Bin Mohd Said (PhD Candidate / Researcher) and Dr David Forrest (PhD Supervisor)

Please initial box

I confirm that I have read and understand the Participant Information Sheet for the above study and have had the opportunity to ask questions. ☐

I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my legal rights being affected. ☐

I understand that all names and other material likely to identify individuals will be anonymised. ☐

I understand that the material will be treated as confidential and kept in secure storage always. ☐

I understand that the material may be used in future publications, both print and online. ☐

I agree to take part in the above study. ☐

______________________________	__________	__________
Name of Participant	Date	Signature
______________________________	__________	__________
Name of Person taking consent (if different from researcher)	Date	Signature
______________________________	__________	__________
Researcher	Date	Signature

(1 copy for subject; 1 copy for researcher)

Appendix B: Participant Questionnaire Form

University of Glasgow | College of Science & Engineering

QUESTIONNAIRE FORM

Research study:

Cartographic Analysis on Application and Development of Whole-Network Bus Map

<u>SECTION A</u>

1. Gender

	Male		Female

2. Age

	18-24		25-34		*34-49*		*50-64*

3. Do you have driving license?

	Yes		No

4. Do you have access to a car? (either as driver or passengers)

	Yes		No

5. Have you ever used bus in the City of Kuantan before?

	Yes		No

6. How frequently do you use bus service?

	Never
	Less than 1 per month
	2 or 3 times per month
	1 or 2 times per week
	More than 3 per week

7. Do you use any other public transportation in Kuantan?

	Yes		No

SECTION B – TASK 1

Task 1 – Based on Geographical Approach bus map (MAP NO 1)

Please refer to bus map no 1 to answer the questions below.

8. If you want to go from **Kubang Buaya** to **UTC Kuantan**, what bus route or routes number will you use?

____ Don't Know ☐

9. What bus route / routes number will you use if you want to go from **Perumahan Semambu** to **Permatang Badak**?

____ Don't Know ☐

10. You want to go to **Bukit Setongkol** from **Taman Indera Sempurna**. After you have arrived at **Bukit Setongkol**, you then need to complete your journey to **Medan Tok Sira**. Please state the bus route/routes number that you will use to complete this journey?

____ Don't Know ☐

11. These routes are easy to find

Strongly disagree	*Disagree*	*Neither disagree nor agree*	*Agree*	*Strongly agree*

12. How confident that you feel that you have identified optimum bus service/services by using this map?

Not at all	*Not confident*	*Neither not confident nor confident*	*Fairly confident*	*Very confident*

<u>SECTION B – TASK 2</u>

Task 2 – Based on Semi-schematic bus map (Map No 2)

Please refer to bus map no 2 to answer the questions below.

13. What bus route / routes number will you use if you want to go from **Indera Mahkota 3** to **Padang MPK 1**?

____ Don't Know ☐

14. If you want to go from **Galing** to **Taman Gelora**, what bus route or routes number will you use?

____ Don't Know ☐

15. You want to go to **Terminal Kuantan Sentral** from **Teluk Cempedak**. After you have arrived at **Terminal Kuantan Sentral**, you then need to complete your journey to **Taman Guru**. Please state the bus route/routes number that you will use to complete this journey?

____Don't Know ☐

16. These routes are easy to find?

Strongly disagree	*Disagree*	*Neither disagree nor agree*	*Agree*	*Strongly agree*

17. How confident you have identified an optimum service by using this map? / I feel that I could easily select the bus route using this map?

Not at all	*Not confident*	*Neither not confident nor confident*	*Fairly confident*	*Very confident*

SECTION C

18. Overall, which one of the maps is easiest to use?

Map 1	*Map 2*

19. Which map would save you the most time when planning a route?

Map 1	*Map 2*

20. Would a network bus map being available make you more as likely to consider using the bus for journeys?

Very Unlikely	*Unlikely*	*Not sure*	*Sure*	*Very Sure*

21. Give your view about the number of landmarks appears on the map.

Too Few	*Few*	*Sufficient*	*Many*	*Too Many*

22. Any comments on the map design and map contents? Please tell me.

____

____

Appendix C: Map Evaluation Form

BUS MAP EVALUATION FORM

Evaluator Name :
Date of Evaluation :
Evaluation Location :

PART 1	GENERAL INFORMATION	DESCRIPTIONS
1.1	Map ID	Individual ID for each map
1.2	Map Title	The original title for each map
1.3	Publication Date	The year of the map published.
1.4	Publisher	The Map Publisher
1.5	Map Location	The depicted location of the map.
1.6	Data Source	Map provider
1.7	Map Size	The size of the paper used to present the map. Divided into two main categories: Small (Smaller than A3 Size) Large (A3 Size & larger)
1.8	Map Coverage Area	The region covered by the map.
1.9	Map Intended User	The target end-user
1.10	Use of Space	Space covered by the map on the paper
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Availability of the element (yes or no)
2.2	Presence of Scale Bar	Availability of the element (yes or no)
2.3	Projection Information	Availability of the information (yes or no)
2.4	Presence of Grids	Availability of the element (yes or no)
2.5	Presence of North Indicator	Availability of the element (yes or no)
2.6	Presence of Legend	Availability of the element (yes or no)
2.7	Legend: Completeness	The level of information placed on the legend section, in terms of completeness, text legibility and type of graphical symbol shown
2.8 2.9	Legend: Legibility Legend: Symbol-likeness	
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	There are two general types of map design classified in this research: 1. Geographical approach 2. Schematic approach
3.2	Type of Geographical Map Design	The specific type of Geographical approach map design: 1. Full-road Network 2. Main-road only 3. Bus-route only

3.3	Type of Schematic Map Design	The specific type of Schematic map design: 1. Full-schematic 2. Semi-schematic
3.4	Category of the Full- Schematic Map Design	The specific type of Schematic map design: 1. Tetralinear to Hexalinear 2. Various Octolinear 3. Decalinear to Curvilinear
3.5	Number of Transportation Mode Shown	The number of Transportation Modes included in the map: 1. Single-mode 2. 2 to 4 modes 3. More than five modes
3.6	Element Use to Differentiate Between Mode	Type of visual variable used to represent information
3.7	Element Use to Differentiate Between Service Line	Type of visual variable used to represent information
3.8	Has bus Number shown on the route?	Availability of the information (yes or no)
3.9	Element Use at Overlapping Situation	Type of visual variable used during overlap situation
PART 4	**BACKGROUND INFORMATION**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Availability of the element (yes or no)
4.2	Hierarchical Level Meet the Map Purpose?	Researcher evaluation (yes or no)
4.3	Boundary Level Shown: Country Border	Availability of the element (yes or no)
4.4	Boundary Level Shown: District Border	Availability of the element (yes or no)
4.5	Boundary Level Shown: City Border	Availability of the element (yes or no)
4.6	Presence of Hydrographic Feature	Availability of the element (yes or no)
4.7	Hydrographic feature: Legibility	Researcher evaluation (clear or not clear)
4.8	Hydrographic feature: Contrast	Researcher evaluation (clear or not clear)
4.9	Presence of Road: Main Road	Availability of the element (yes or no)
4.11	Presence of Road: Minor Road	Availability of the element (yes or no)
4.12	Presence of Road: Other Road	Availability of the element (yes or no)
4.13	Presence of Road: Railway/tram/metro route	Availability of the element (yes or no)
4.14	Presence of Road: Footpath	Availability of the element (yes or no)
4.15	Presence of Landmark	Availability of the element (yes or no)
4.16	Number of Landmarks	Researcher evaluation (many – few)
4.17	Inset Map Availability	Availability of the element (yes or no)
4.18	Inset Map: Category	Type of inset map

4.19	Does Inset Map meet map purpose?	Researcher evaluation (yes or no)
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour: Efficiency	Researcher evaluation (yes or no)
5.2	Colour: Colour or Black and white	Type of colour used
5.3	Colour: Enhance Map Usage?	Researcher evaluation (efficient - unsatisfactory)
5.4	Line: Number of Line Types	No of Line Types shown: 1. Less than 2 2. Between 3 to 5 3. More Than 5
5.5	Line: Legibility	Researcher evaluation (Clear or Not Clear)
5.6	Line: Contrast Level	Researcher evaluation (Clear or Not Clear)
5.7	Line: follow the feature's shape?	Researcher evaluation (yes or no)
5.8	Typography : Font size	Researcher evaluation (Small, Medium, Large)
5.9	Typography: Legibility	Researcher evaluation (Clear or Not Clear)
5.10	Typography: Contrast	Researcher evaluation (Clear or Not Clear)
5.11	Typography : Placement	Researcher evaluation (Suitable or Not Suitable)
5.12	Typography: Numbers of Text	Researcher evaluation (many – few)
5.13	Symbology: Shape	Type of symbology used: 1. Conventional 2. Intuitive
5.14	Symbology: Explanation Given?	Availability of the element (yes or no)
5.15	Symbology: Explanation on Abbv	Availability of the element (yes or no)
5.16	Symbology: Legibility	Researcher evaluation (Clear or Not Clear)
5.17	Symbology: Contrast	Researcher evaluation (Clear or Not Clear)

Appendix D: Map Evaluation Form

(55 Bus Maps)

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 15 August 2016
Evaluation Location : University of Glasgow

PART 1	GENERAL INFORMATIONS	DESCRIPTIONS
1.1	Map ID	EU_01_10
1.2	Map Title	Ile-de France
1.3	Publication Date	2010
1.4	Publisher	Autonomous Operator of Parisian Transports - RATP
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Medium
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Various Octolinear
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	No
4.7	Hydrographic feature : Legibility	Not Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	No
4.16	Number of Landmarks	Not Applicable
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Not clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 15 August 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_02_07
1.2	Map Title	Paris
1.3	Publication Date	2007
1.4	Publisher	Autonomous Operator of Parisian Transports - RATP
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Medium
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Various Octolinear
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	No
4.7	Hydrographic feature : Legibility	Not Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	No
4.16	Number of Landmarks	Not Applicable
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Not clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 15 August 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_03_16
1.2	Map Title	Plan De reseau - Geneva
1.3	Publication Date	2016
1.4	Publisher	Uniresco
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Tetralinear to Hexalinear
3.5	Number of Transportation Mode Shown	Five or More Modes
3.6	Element Use to Differentiate Between Mode	Combination between 2 or more variables
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 15 August 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_04_08
1.2	Map Title	Lijnennetkaart 2008 - Amsterdam
1.3	Publication Date	2008
1.4	Publisher	GVB
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Five or More Modes
3.6	Element Use to Differentiate Between Mode	Combination between 2 or more variables
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Not Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too Many
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Not Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 15 August 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_05_12
1.2	Map Title	Lijnennetkaart 2012 - Amsterdam
1.3	Publication Date	2012
1.4	Publisher	GVB
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Five or More Modes
3.6	Element Use to Differentiate Between Mode	Combination between 2 or more variables
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too Many
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Not Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 18 August 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_06_13
1.2	Map Title	Dresden _ Mit bus and bahn die region entdecken
1.3	Publication Date	2013
1.4	Publisher	VVO
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Combination between 2 or more variables
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes

4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	Yes
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Not clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Not Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 18 August 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_07_13
1.2	Map Title	Liniennetz - Dresden
1.3	Publication Date	2013
1.4	Publisher	DVB
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Medium
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Tetralinear to Hexalinear
3.5	Number of Transportation Mode Shown	Five or More Modes
3.6	Element Use to Differentiate Between Mode	Combination between 2 or more variables
3.7	Element Use to Differentiate Between Service Line	Combination between 2 or more variables
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	Yes

4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	More than 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 19 August 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_08_08
1.2	Map Title	Dresdner Linien
1.3	Publication Date	2008
1.4	Publisher	DVB - VVO
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Various Octolinear
3.5	Number of Transportation Mode Shown	Five or More Modes
3.6	Element Use to Differentiate Between Mode	Combination between 2 or more variables
3.7	Element Use to Differentiate Between Service Line	Combination between 2 or more variables
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes

4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	More than 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 19 August 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_09_11
1.2	Map Title	Copenhagen - Byens Net Guide
1.3	Publication Date	2011
1.4	Publisher	The City Net
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	Yes
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Semi Schematic
3.4	Category of the Schematic Map Design	Tetralinear to Hexalinear
3.5	Number of Transportation Mode Shown	Five or More Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Use a different variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Not Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Not Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 19 August 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_10_11
1.2	Map Title	Geneve - Plan De Reseau
1.3	Publication Date	2012
1.4	Publisher	TPG - Transport Publics Genevois
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Main Road
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	Yes

4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too Many
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Not Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 19 September 2016
Evaluation Location : University of Glasgow

PART 1	GENERAL INFORMATIONS	DESCRIPTIONS
1.1	Map ID	EU_11_10
1.2	Map Title	Montpellier - Plan De Reseau (1 - Front)
1.3	Publication Date	2010
1.4	Publisher	TAM - Transport de l'agglomeration de Montpellier
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes

4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	Yes
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Not Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 19 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_12_10
1.2	Map Title	Montpellier - Plan De Reseau (2 - Back)
1.3	Publication Date	2010
1.4	Publisher	TAM - Transport de l'agglomeration de Montpellier
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	Yes
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes

4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Not Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 19 September 2016
Evaluation Location : University of Glasgow

PART 1	GENERAL INFORMATIONS	DESCRIPTIONS
1.1	Map ID	EU_13_14
1.2	Map Title	Geneve - Plan De Reseau
1.3	Publication Date	2014
1.4	Publisher	TPG - Transport Publics genevois
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Semi Schematic
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	Yes
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No
5.16	Symbology : Legibility	Not Clear
5.17	Symbology: Contrast	Not Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 19 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_14_13
1.2	Map Title	Integrated Transport System of the Olomouc Region
1.3	Publication Date	2013
1.4	Publisher	Coordinator of IDSOK
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Medium
1.8	Map Coverage Area	State Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Medium
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Have Scale
2.2	Presence of Scale Bar	Yes
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	No
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Main Road
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	No
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	Yes
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	No
4.7	Hydrographic feature : Legibility	Not Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	No
4.16	Number of Landmarks	Not Applicable
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Not Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Large
5.9	Typography : Legibility	Not Clear
5.10	Typography : Contrast	Not clear
5.11	Typography : Placement	Not suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No
5.16	Symbology : Legibility	Not Clear
5.17	Symbology: Contrast	Not Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 20 September 2016
Evaluation Location : University of Glasgow

PART 1	GENERAL INFORMATIONS	DESCRIPTIONS
1.1	Map ID	EU_15_11
1.2	Map Title	Les transports en ile-de-france
1.3	Publication Date	2011
1.4	Publisher	STIF
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	Yes
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Tetralinear to Hexalinear
3.5	Number of Transportation Mode Shown	Five or More Modes
3.6	Element Use to Differentiate Between Mode	Combination between two or more variables
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	Yes
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes

4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	No
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Not Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 20 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_16_08
1.2	Map Title	Trips and Traffic in Dresden
1.3	Publication Date	2008
1.4	Publisher	DVB + VVO
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Small
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Various Octolinear
3.5	Number of Transportation Mode Shown	Five or More Modes
3.6	Element Use to Differentiate Between Mode	Combination between two or more variables
3.7	Element Use to Differentiate Between Service Line	Combination between two or more variables
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes

4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	No
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 20 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_17_05
1.2	Map Title	Paris - Plan de Poche
1.3	Publication Date	2005
1.4	Publisher	Autonomous Operator of Parisian Transports - RATP
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Small
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Various Octolinear
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	No
4.16	Number of Landmarks	Not Applicable
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Not Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 20 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_18_14
1.2	Map Title	Map network connections ZTM Poznan
1.3	Publication Date	2014
1.4	Publisher	ZTM Poznan
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Small
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	No
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Not Clear
2.9	Legend : Symbol-likeness	No
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	No
4.16	Number of Landmarks	Not Applicable
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Not clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 09 February 2017
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_19_16
1.2	Map Title	Delijn - Brugge City center
1.3	Publication Date	2016
1.4	Publisher	De Lijn
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Not applicable
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Not Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	Yes

4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	Yes
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Not clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 09 February 2017
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_20_16
1.2	Map Title	Plan De Reseau - Network Map Brussels
1.3	Publication Date	2016
1.4	Publisher	MVB - STIB
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Various Octolinear
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Combination between two or more variables
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	No
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes

4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	Yes
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	No
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 09 February 2017
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	EU_21_17
1.2	Map Title	Delijn - Gent
1.3	Publication Date	2017
1.4	Publisher	De Lijn
1.5	Map Location	Europe
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Have Scale
2.2	Presence of Scale Bar	Yes
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Not applicable
3.7	Element Use to Differentiate Between Service Line	Combination between two or more variables
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	Yes
4.15	Presence of Landmark	No
4.16	Number of Landmarks	Not Applicable
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	More than 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 21 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	SCO_001_75
1.2	Map Title	Greater Glasgow Transport Map
1.3	Publication Date	1975
1.4	Publisher	Greater Glasgow Passenger Transport Executive
1.5	Map Location	United Kingdom
1.6	Data Source	Public-private Initiative
1.7	Map Size	Large
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Have Scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Main Road
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Not Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 21 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	SCO_002_98
1.2	Map Title	Getting to Glasgow Airport by Road and Rail
1.3	Publication Date	1998
1.4	Publisher	Glasgow Airport
1.5	Map Location	United Kingdom
1.6	Data Source	Government
1.7	Map Size	Medium
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Specific Usage
1.10	Use of Space	Medium
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	Yes
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Various Octolinear
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	No
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	No
4.11	Presence of Road : Minor Road	Yes

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	No
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Not Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 21 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	SCO_003_98
1.2	Map Title	Edinburgh Travel map
1.3	Publication Date	1998
1.4	Publisher	Edinburgh City council
1.5	Map Location	United Kingdom
1.6	Data Source	Government
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	Yes
2.3	Projection Information	No
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	No
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Combination between two or more variables
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	Yes
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	No
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Not Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Not clear
5.11	Typography : Placement	Not suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Not Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 21 September 2016
Evaluation Location : University of Glasgow

PART 1	GENERAL INFORMATIONS	DESCRIPTIONS
1.1	Map ID	SCO_004_06
1.2	Map Title	Glasgow Mapmate
1.3	Publication Date	2006
1.4	Publisher	Firstgroup
1.5	Map Location	United Kingdom
1.6	Data Source	Private
1.7	Map Size	Medium
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	Yes
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	No
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	No
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Not applicable
3.7	Element Use to Differentiate Between Service Line	Combination between two or more variables
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Use a different variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Not Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Not clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	No
5.16	Symbology : Legibility	Not Clear
5.17	Symbology: Contrast	Not Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 22 September 2016
Evaluation Location : University of Glasgow

PART 1	GENERAL INFORMATIONS	DESCRIPTIONS
1.1	Map ID	SCO_005_13
1.2	Map Title	Glasgow All-On-One
1.3	Publication Date	2013
1.4	Publisher	Firstgroup
1.5	Map Location	United Kingdom
1.6	Data Source	Private
1.7	Map Size	Medium
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	No
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Main Road
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Combination between two or more variables
3.7	Element Use to Differentiate Between Service Line	Combination between two or more variables
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes

4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	Yes
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	Yes
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too Many
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Not Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Not clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Not Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 22 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	SCO_006_97
1.2	Map Title	Visitor Transport Guide
1.3	Publication Date	1997
1.4	Publisher	SPT
1.5	Map Location	United Kingdom
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	No
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Line
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Use a different variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	Yes

4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too Many
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Not suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 22 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	SCO_007_10
1.2	Map Title	Regional Public Transport Map
1.3	Publication Date	2010
1.4	Publisher	SAStrans
1.5	Map Location	United Kingdom
1.6	Data Source	Public-private Initiative
1.7	Map Size	Large
1.8	Map Coverage Area	State Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Have Scale
2.2	Presence of Scale Bar	Yes
2.3	Projection Information	Yes
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Bus Only
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	Yes
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	No
4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too Many
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Overview Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 23 September 2016
Evaluation Location : University of Glasgow

PART 1	GENERAL INFORMATIONS	DESCRIPTIONS
1.1	Map ID	UK_001_11
1.2	Map Title	London By bus
1.3	Publication Date	2011
1.4	Publisher	Quickmap
1.5	Map Location	United Kingdom
1.6	Data Source	Government
1.7	Map Size	Medium
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	No
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Main Road
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Combination between two or more variables
3.7	Element Use to Differentiate Between Service Line	Combination between two or more variables
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes

4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	Yes
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too Many
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Overview Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Not Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Not clear
5.11	Typography : Placement	Not suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	No
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 23 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	UK_002_12
1.2	Map Title	York Bus Route Map
1.3	Publication Date	2012
1.4	Publisher	City of York council
1.5	Map Location	United Kingdom
1.6	Data Source	Public-private Initiative
1.7	Map Size	Large
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Not applicable
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 23 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	UK_003_10
1.2	Map Title	Public Transport Information by Southampton Council
1.3	Publication Date	2010
1.4	Publisher	Southampton City Council
1.5	Map Location	United Kingdom
1.6	Data Source	Public-private Initiative
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Semi Schematic
3.4	Category of the Schematic Map Design	Various Octolinear
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Number
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Not Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 23 September 2016
Evaluation Location : University of Glasgow

PART 1	GENERAL INFORMATIONS	DESCRIPTIONS
1.1	Map ID	UK_004_14
1.2	Map Title	UniLink- times and maps
1.3	Publication Date	2014
1.4	Publisher	Unilink
1.5	Map Location	United Kingdom
1.6	Data Source	Private
1.7	Map Size	Small
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Specific Usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	No
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Semi Schematic
3.4	Category of the Schematic Map Design	Various Octolinear
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Not applicable
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	No
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	No
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 26 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	UK_005_09
1.2	Map Title	Chesterfield - stagecoach
1.3	Publication Date	2009
1.4	Publisher	Stagecoach
1.5	Map Location	United Kingdom
1.6	Data Source	Government
1.7	Map Size	Large
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Main Road
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Line
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	Yes
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Not Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Not Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 26 September 2016
Evaluation Location : University of Glasgow

PART 1	GENERAL INFORMATIONS	DESCRIPTIONS
1.1	Map ID	UK_006_98
1.2	Map Title	Newcastle A Passenger Area
1.3	Publication Date	1998
1.4	Publisher	Nexus
1.5	Map Location	United Kingdom
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Line
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	Yes
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	Yes

4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	Yes
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	More than 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Not Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Not suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 26 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	UK_007_95
1.2	Map Title	Oxford Bus Company
1.3	Publication Date	1995
1.4	Publisher	Oxford Bus Company
1.5	Map Location	United Kingdom
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Minimal
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	No
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Not Clear
2.9	Legend : Symbol-likeness	No
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Not applicable
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	No
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	No Hydro Features
4.7	Hydrographic feature : Legibility	Not Applicable
4.8	Hydrographic feature : Contrast	Not Applicable
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too few
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 26 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	UK_008_00
1.2	Map Title	Oxford Bus Route and service guide
1.3	Publication Date	2000
1.4	Publisher	Oxford Bus
1.5	Map Location	United Kingdom
1.6	Data Source	Private
1.7	Map Size	Small
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	Yes
2.3	Projection Information	No
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Semi Schematic
3.4	Category of the Schematic Map Design	Decalinear to Curvilinear
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Combination between two or more variables
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes

4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	No
4.16	Number of Landmarks	Not Applicable
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 26 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	UK_009_14
1.2	Map Title	Xelabus Town & Village Link
1.3	Publication Date	2014
1.4	Publisher	Eastleigh's Green Bus Company
1.5	Map Location	United Kingdom
1.6	Data Source	Private
1.7	Map Size	Small
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Minimal
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	No
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Decalinear to Curvilinear
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Not applicable
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	No
4.7	Hydrographic feature : Legibility	Not Applicable
4.8	Hydrographic feature : Contrast	Not Applicable
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Large
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Not Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 26 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	UK_010_90
1.2	Map Title	Out and about in Tyne and Wear
1.3	Publication Date	1990
1.4	Publisher	Tyne and Wear Passenger Transport
1.5	Map Location	United Kingdom
1.6	Data Source	Public-private Initiative
1.7	Map Size	Large
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Have Scale
2.2	Presence of Scale Bar	Yes
2.3	Projection Information	No
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Line
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	Yes
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes

4.12	Presence of Road : Other Road	Yes
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Overview Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 29 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	UK_011_09
1.2	Map Title	Southampton Airport Travel
1.3	Publication Date	2009
1.4	Publisher	Southampton Airport
1.5	Map Location	United Kingdom
1.6	Data Source	Private
1.7	Map Size	Small
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	No
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Not Clear
2.9	Legend : Symbol-likeness	No
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Main Road
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Combination between two or more variables
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Not Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 29 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	UK_012_93
1.2	Map Title	Map and Guide Birmingham
1.3	Publication Date	1993
1.4	Publisher	Centro
1.5	Map Location	United Kingdom
1.6	Data Source	Public-private Initiative
1.7	Map Size	Large
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Have Scale
2.2	Presence of Scale Bar	Yes
2.3	Projection Information	No
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Combination between two or more variables
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	Yes
4.5	Boundary Level Shown : City Border	Yes
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Not Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Both Detail and Overview Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Not Clear
5.17	Symbology: Contrast	Not Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 29 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	UK_13_10
1.2	Map Title	Bus Guide for the New Forrest Christchurch, New Milton, Lymington, Ringwood
1.3	Publication Date	2010
1.4	Publisher	Wilts and Dorset
1.5	Map Location	United Kingdom
1.6	Data Source	Private
1.7	Map Size	Small
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Minimal
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	No
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Not Clear
2.9	Legend : Symbol-likeness	No
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Semi Schematic
3.4	Category of the Schematic Map Design	Decalinear to Curvilinear
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes

4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Both Detail and Overview Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too few
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 29 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	UK_14_16
1.2	Map Title	Route Map - Lothian Buses and Edinburgh Trams
1.3	Publication Date	2016
1.4	Publisher	Lothian Buses
1.5	Map Location	United Kingdom
1.6	Data Source	Private
1.7	Map Size	Small
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Tetralinear to Hexalinear
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too Many
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Large
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 29 September 2016
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	UK_15_05
1.2	Map Title	Bus Services from King's Cross
1.3	Publication Date	2005
1.4	Publisher	Transport of London
1.5	Map Location	United Kingdom
1.6	Data Source	Private
1.7	Map Size	Small
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	No
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Tetralinear to Hexalinear
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	No
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	No
4.7	Hydrographic feature : Legibility	Not Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	No
4.16	Number of Landmarks	Not Applicable
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 17 January 2017
Evaluation Location : University of Glasgow

PART 1	GENERAL INFORMATIONS	DESCRIPTIONS
1.1	Map ID	US_01_10
1.2	Map Title	Milwaukee County Transit Guide
1.3	Publication Date	2010
1.4	Publisher	Milwaukee County
1.5	Map Location	North America
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Semi Schematic
3.4	Category of the Schematic Map Design	Tetralinear to Hexalinear
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 17 January 2017
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	US_02_11
1.2	Map Title	Milwaukee County Transit Guide
1.3	Publication Date	2011
1.4	Publisher	Milwaukee County
1.5	Map Location	North America
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Various Octolinear
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 17 January 2017
Evaluation Location : University of Glasgow

PART 1	GENERAL INFORMATIONS	DESCRIPTIONS
1.1	Map ID	US_03_12
1.2	Map Title	Milwaukee County Transit Guide
1.3	Publication Date	2012
1.4	Publisher	Milwaukee County
1.5	Map Location	North America
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Various Octolinear
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Line
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 21 January 2017
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	US_04_10
1.2	Map Title	Bus and Rail Map - Chicago
1.3	Publication Date	2010
1.4	Publisher	Chicago Transit Authority
1.5	Map Location	North America
1.6	Data Source	Public-private Initiative
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	Yes
2.3	Projection Information	No
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Combination between two or more variables
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too Many
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	More than 5
5.5	Line : Legibility	Not Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	Yes
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 21 January 2017
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	US_05_96
1.2	Map Title	Transit Map - Miami-Dade County
1.3	Publication Date	1996
1.4	Publisher	Miami-Dade Transit
1.5	Map Location	North America
1.6	Data Source	Government
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Medium
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Have Scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	Yes
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	No
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Semi Schematic
3.4	Category of the Schematic Map Design	Tetralinear to Hexalinear
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	No
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 21 January 2017
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	US_06_15
1.2	Map Title	DC Circulator Map & Information Guide
1.3	Publication Date	2015
1.4	Publisher	DC Circulator
1.5	Map Location	North America
1.6	Data Source	Government
1.7	Map Size	Medium
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	Yes
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Full Road Network
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Not applicable
3.7	Element Use to Differentiate Between Service Line	Colour
3.8	Bus Number shown on the route?	No
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes

4.12	Presence of Road : Other Road	Yes
4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	Yes
4.18	Inset Map : Category	Detail Map
4.19	Inset Map meet map purpose?	Yes
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	Yes
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Small
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Not clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Familiar
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 21 January 2017
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	US_07_15
1.2	Map Title	96,97 Metrobus
1.3	Publication Date	2015
1.4	Publisher	Metrobus
1.5	Map Location	North America
1.6	Data Source	Public-private Initiative
1.7	Map Size	Medium
1.8	Map Coverage Area	District Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Minimal
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	Not to scale
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	No
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Geographical
3.2	Type of Geographical Map Design	Main Road
3.3	Type of Schematic Map Design	Not Applicable
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Not applicable
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	Yes
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Not Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Too few
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Efficient
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Not clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Sufficient
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 21 January 2017
Evaluation Location : University of Glasgow

PART 1	GENERAL INFORMATIONS	DESCRIPTIONS
1.1	Map ID	US_08_15
1.2	Map Title	Virginia - Metrobus System Map
1.3	Publication Date	2015
1.4	Publisher	Metrobus
1.5	Map Location	North America
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	No Scale Given
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Semi Schematic
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Combination between two or more variables
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes
4.11	Presence of Road : Minor Road	Yes

4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	No
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 23 January 2017
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	US_09_15
1.2	Map Title	Montgomery County - Metro System Map
1.3	Publication Date	2015
1.4	Publisher	Metrobus
1.5	Map Location	North America
1.6	Data Source	Private
1.7	Map Size	Large
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Full
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	No Scale Given
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	Yes
2.8	Legend : Legibility	Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Semi Schematic
3.4	Category of the Schematic Map Design	NA
3.5	Number of Transportation Mode Shown	Between 2 to 4 Modes
3.6	Element Use to Differentiate Between Mode	Colour
3.7	Element Use to Differentiate Between Service Line	Combination between two or more variables
3.8	Bus Number shown on the route?	Yes
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	Yes
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	Yes
4.7	Hydrographic feature : Legibility	Clear
4.8	Hydrographic feature : Contrast	Clear
4.9	Presence of Road : Main Road	Yes

4.11	Presence of Road : Minor Road	Yes
4.12	Presence of Road : Other Road	No
4.13	Presence of Road : Railway/tram/metro route	Yes
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	Yes
4.16	Number of Landmarks	Sufficient
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Between 3 to 5
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	Yes
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	No
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 23 January 2017
Evaluation Location : University of Glasgow

PART 1	**GENERAL INFORMATIONS**	**DESCRIPTIONS**
1.1	Map ID	US_10_12
1.2	Map Title	30 Sherman - Winconsin
1.3	Publication Date	2012
1.4	Publisher	Milwaukee County
1.5	Map Location	North America
1.6	Data Source	Private
1.7	Map Size	Small
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Minimal
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	No Scale Given
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Not Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Tetralinear to Hexalinear
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Number
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	No
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	No
4.7	Hydrographic feature : Legibility	Not Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	No
4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	No
4.16	Number of Landmarks	Not Applicable
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	No
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 23 January 2017
Evaluation Location : University of Glasgow

PART 1	GENERAL INFORMATIONS	DESCRIPTIONS
1.1	Map ID	US_11_12
1.2	Map Title	63 Silver Spring - Port Washington
1.3	Publication Date	2012
1.4	Publisher	Milwaukee County
1.5	Map Location	North America
1.6	Data Source	Private
1.7	Map Size	Small
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Minimal
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	No Scale Given
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Not Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Tetralinear to Hexalinear
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Number
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	No
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	No
4.7	Hydrographic feature : Legibility	Not Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	No
4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	No
4.16	Number of Landmarks	Not Applicable
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	No
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

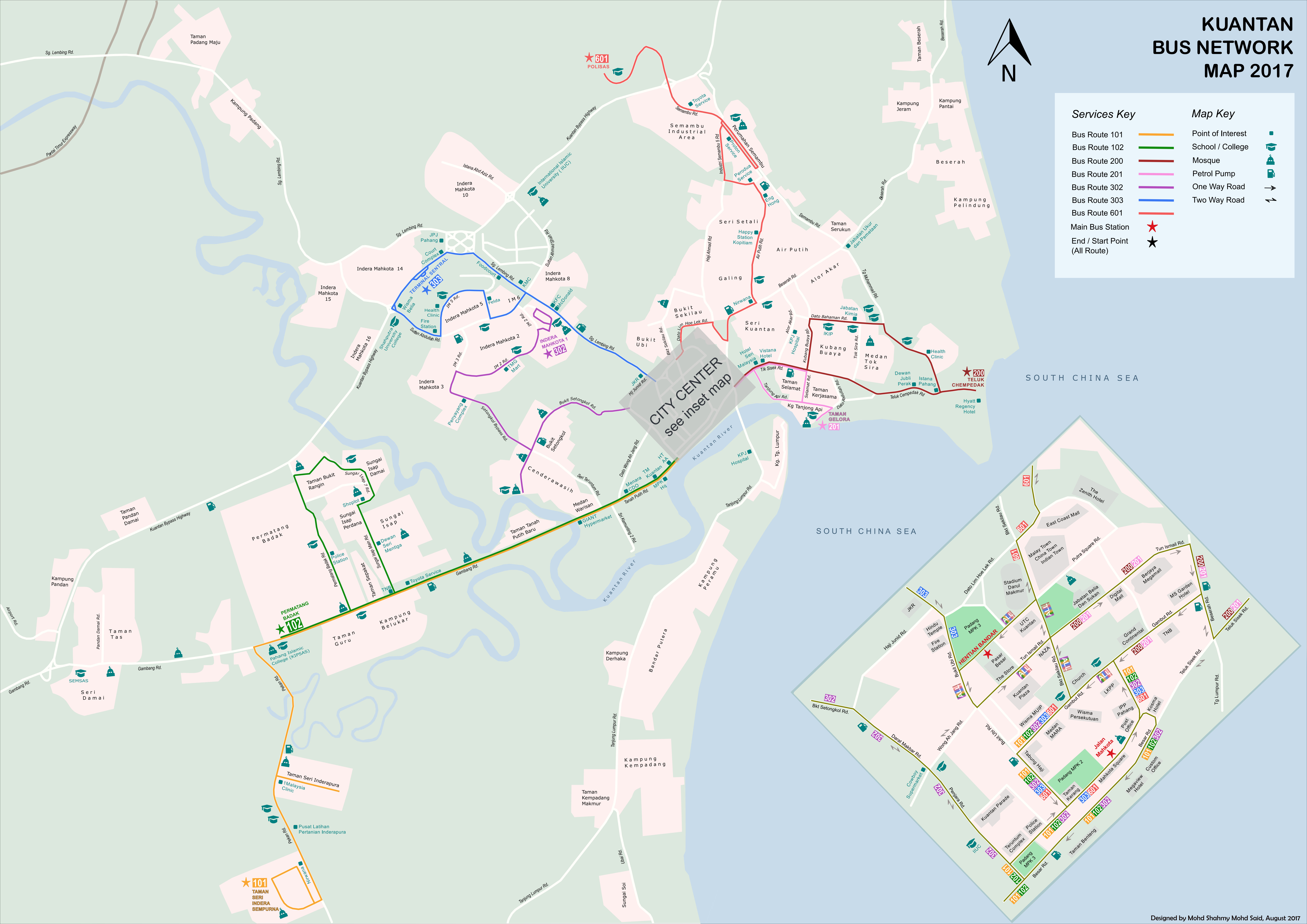
BUS MAP EVALUATION FORM

Evaluator Name : Mohd Shahmy Bin Mohd Said
Date of Evaluation : 23 January 2017
Evaluation Location : University of Glasgow

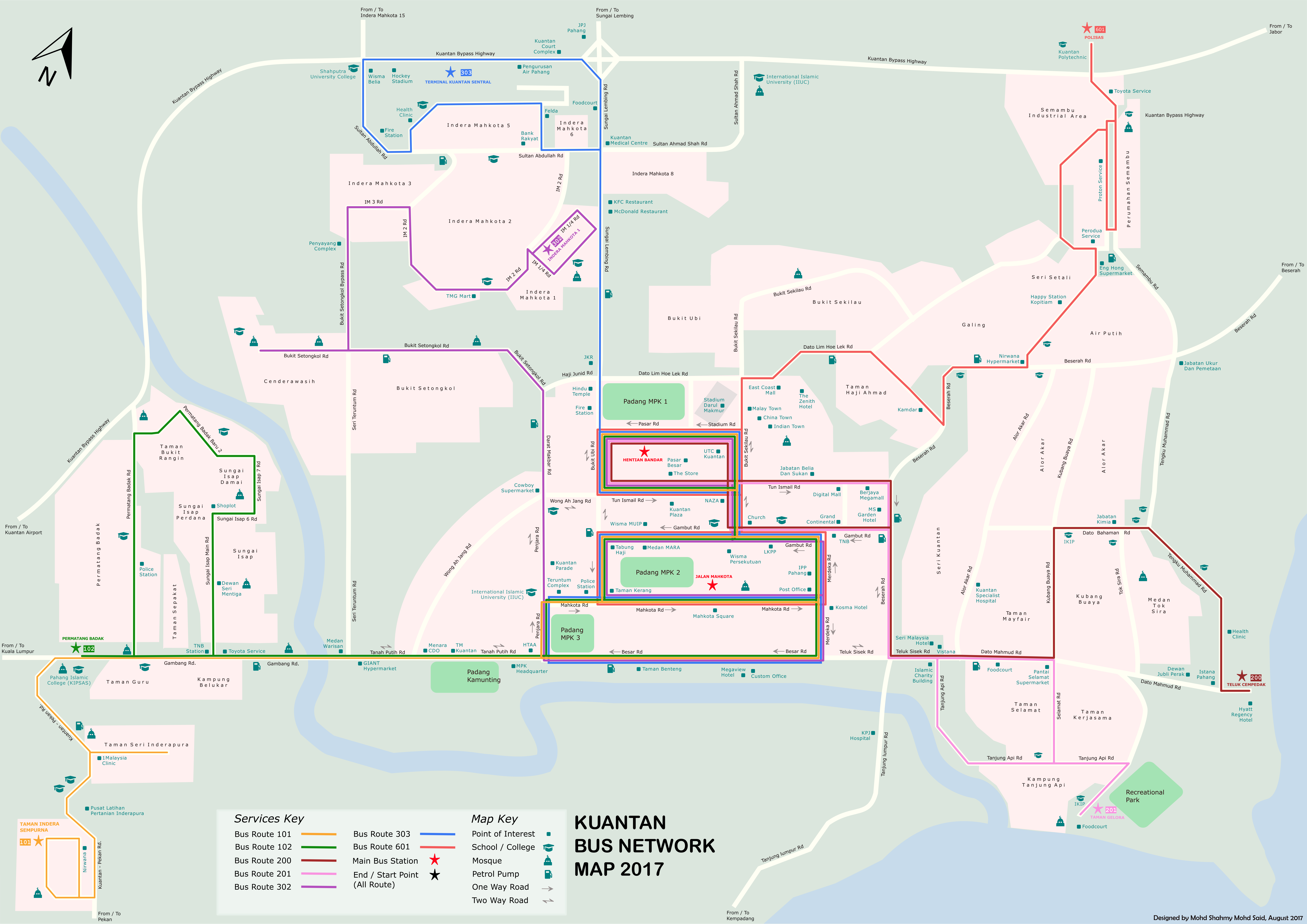
PART 1	GENERAL INFORMATIONS	DESCRIPTIONS
1.1	Map ID	US_12_12
1.2	Map Title	Green Line Bayshore - Airport
1.3	Publication Date	2012
1.4	Publisher	Milwaukee County
1.5	Map Location	North America
1.6	Data Source	Private
1.7	Map Size	Small
1.8	Map Coverage Area	City Level
1.9	Map Intended User	Public usage
1.10	Use of Space	Minimal
PART 2	**MAP ELEMENTS**	**DESCRIPTIONS**
2.1	Presence of Scale	No Scale Given
2.2	Presence of Scale Bar	No
2.3	Projection Information	No
2.4	Presence of Grids	No
2.5	Presence of North Indicator	Yes
2.6	Presence of Legend	Yes
2.7	Legend : Completeness	No
2.8	Legend : Legibility	Not Clear
2.9	Legend : Symbol-likeness	Yes
PART 3	**MAP DESIGN**	**DESCRIPTIONS**
3.1	Type of Map design	Schematic
3.2	Type of Geographical Map Design	Not Applicable
3.3	Type of Schematic Map Design	Full Schematic
3.4	Category of the Schematic Map Design	Tetralinear to Hexalinear
3.5	Number of Transportation Mode Shown	Single Mode
3.6	Element Use to Differentiate Between Mode	Number
3.7	Element Use to Differentiate Between Service Line	Number
3.8	Bus Number shown on the route?	No
3.9	Element Use at Overlapping Situation	Maintain the same variable
PART 4	**BACKGROUND INFORMATIONS**	**DESCRIPTIONS**
4.1	Presence of Map Hierarchical Level	No
4.2	Hierarchical Level Meet the Map Purpose?	No
4.3	Boundary Level Shown : Country Border	No
4.4	Boundary Level Shown : District Border	No
4.5	Boundary Level Shown : City Border	No
4.6	Presence of Hydrographic Feature	No
4.7	Hydrographic feature : Legibility	Not Clear
4.8	Hydrographic feature : Contrast	Not Clear
4.9	Presence of Road : Main Road	No
4.11	Presence of Road : Minor Road	No
4.12	Presence of Road : Other Road	No

4.13	Presence of Road : Railway/tram/metro route	No
4.14	Presence of Road : Footpath	No
4.15	Presence of Landmark	No
4.16	Number of Landmarks	Not Applicable
4.17	Inset Map Availability	No
4.18	Inset Map : Category	Not Applicable
4.19	Inset Map meet map purpose?	Not applicable
PART 5	**VISUAL VARIABLES USE**	**DESCRIPTIONS**
5.1	Colour : Efficiency	No
5.2	Colour : Colour or Black and white	Colour
5.3	Colour: Enhance Map Usage?	Moderate
5.4	Line : Number of Line Types	Less than 2
5.5	Line : Legibility	Clear
5.6	Line : Contrast Level	Clear
5.7	Line: follow feature's shape?	No
5.8	Typography : Font size	Medium
5.9	Typography : Legibility	Clear
5.10	Typography : Contrast	Clear
5.11	Typography : Placement	Suitable
5.12	Typography : Numbers of Text	Too many
5.13	Symbology : Shape	Intuitive
5.14	Symbology : Explanation Given?	Yes
5.15	Symbology : Explanation on Abbv	No Abbv
5.16	Symbology : Legibility	Clear
5.17	Symbology: Contrast	Clear

Appendix E: The Whole-network Bus Map Prototypes



KUANTAN
BUS NETWORK
MAP 2017
N
Services Key
Bus Route 101
Bus Route 102
Bus Route 200
Bus Route 201
Bus Route 302
Bus Route 303
Bus Route 601
Main Bus Station
End / Start Point (All Route)
Map Key
Point of Interest
School / College
Mosque
Petrol Pump
One Way Road
Two Way Road
SOUTH CHINA SEA
CITY CENTER see inset map
601 POLISAS
200 TELUK CHEMPEDAK
201 TAMAN GELORA
302 INDERA MAHKOTA 1
303 TERMINAL SENTRAL
102 PERMATANG BADAK
101 TAMAN SERI INDERA SEMPURNA
HENTIAN BANDAR
Jalan Mahkota
Kuantan River
Designed by Mohd Shahmy Mohd Said, August 2017


KUANTAN
BUS NETWORK
MAP 2017
Services Key
Bus Route 101
Bus Route 102
Bus Route 200
Bus Route 201
Bus Route 302
Bus Route 303
Bus Route 601
Main Bus Station
End / Start Point (All Route)
Map Key
Point of Interest
School / College
Mosque
Petrol Pump
One Way Road
Two Way Road
N
From / To Indera Mahkota 15
From / To Sungai Lembing
From / To Jabor
From / To Beserah
From / To Kuantan Airport
From / To Kuala Lumpur
From / To Pekan
From / To Kempadang
Kuantan Bypass Highway
TERMINAL KUANTAN SENTRAL
303
POLISAS
601
INDERA MAHKOTA 1
302
HENTIAN BANDAR
JALAN MAHKOTA
PERMATANG BADAK
102
TELUK CEMPEDAK
200
TAMAN GELORA
201
TAMAN INDERA SEMPURNA
101
Padang MPK 1
Padang MPK 2
Padang MPK 3
Padang Kamunting
Recreational Park
Indera Mahkota 2
Indera Mahkota 3
Indera Mahkota 5
Indera Mahkota 6
Indera Mahkota 8
Semambu Industrial Area
Bukit Setongkol
Cenderawasih
Bukit Ubi
Bukit Sekilau
Seri Setali
Galing
Air Putih
Taman Haji Ahmad
Taman Bukit Rangin
Sungai Isap Damai
Sungai Isap Perdana
Sungai Isap
Permatang Badak
Taman Sepakat
Taman Guru
Kampung Belukar
Taman Seri Inderapura
Seri Kuantan
Taman Mayfair
Kubang Buaya
Medan Tok Sira
Taman Selamat
Taman Kerjasama
Kampung Tanjung Api
Sultan Abdullah Rd
Sungai Lembing Rd
Sultan Ahmad Shah Rd
Bukit Setongkol Rd
Bukit Sekilau Rd
Dato Lim Hoe Lek Rd
Haji Junid Rd
Pasar Rd
Stadium Rd
Tun Ismail Rd
Gambut Rd
Mahkota Rd
Besar Rd
Tanah Putih Rd
Gambang Rd.
Teluk Sisek Rd
Dato Mahmud Rd
Beserah Rd
Tanjung Api Rd
Tanjung Lumpur Rd
Kuantan - Pekan Rd
Designed by Mohd Shahmy Mohd Said, August 2017