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Road or track in urban public transport?

Knowledge claims about the choice between Bus Rapid Transit and Light Rail Transit in research and in practice

Fredrik Pettersson-Löfstedt

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Foreword

The choice between road-based, such as Bus Rapid Transit (BRT), or track-based, such as Light Rail Transit (LRT), urban public transport systems, is often characterized by lively debates. It is not uncommon for proponents of one option or the other to have strong opinions about why that particular option is best. This report is not about which is better of BRT or LRT, but aims to step back to help open up a discussion of knowledge claims about the choice between BRT and LRT in research and in practice.

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Fredrik Pettersson-Löfstedt

Project manager

Summary

Many mid-sized to large cities struggle to provide efficient and attractive sustainable transport systems. In many cities metro is not a viable option, and choice is therefore restricted to surface-level high capacity transport technologies. The main competing technologies available are either track-based, such as trams or light rail (LRT), or road-based, such as buses with high levels of service (BHLS) or bus rapid transit (BRT).

In general, benchmarking studies have shown that road-based solutions can supply the same capacity as track-based systems at a lower investment cost. Despite this, there are plenty of examples where decisions to build track-based systems have been made. This report is an attempt to shed new light on this apparent conflict between transport professional appraisal, which in many cases has been "pro-bus", and "pro-track" political decision making. A point of departure in the report is that decision-makers may have frames of reference guiding their decisions that are different from knowledge available in existing transport research appraisal frameworks.

The purpose of this study is therefore to compare, contrast, and critically examine knowledge claims in research, and in decision making, on the choice between track-based or road-based urban public transport systems.

The following research questions are posed:

- What kind of knowledge claims about the choice of urban public transport technologies (track-based or road-based) are made in research?
- What kind of knowledge claims about the choice of urban public transport technologies (track-based or road-based) are made in planning practice?
- Are the knowledge claims in research and in planning practice consistent, or are there any major discrepancies?

The method in the study comprises two components, an integrative literature review of knowledge claims in research, and a comparative case study of two Swedish cities; Helsingborg where BRT has been built, and Lund where LRT has been built.

The knowledge claims in research are categorised according to their ontological and epistemological points of departure, where I distinguish between studies with a positivistic, descriptive approach, and studies with a hermeneutic, interpretive approach. In addition, three broad analytical constructs are used to categorise the field of the study:

- transport economics (papers focusing on issues such as investment costs, benefits for users, and operational and maintenance costs).
- transport functionality (papers focusing on transport engineering issues, such as commercial speeds, right of way, level of service and headways).

- urban development (papers focusing on impacts on real estate prices and other types of effects on urban development, decision-making processes, and the influence of local planning and politics on the choice of transport technology).

The results of the study are structured through the three research questions.

What kind of knowledge claims about the choice of urban public transport technologies (track-based or road-based) are made in research?

There are few examples of studies explicitly focusing on understanding the choice of transport technology, at least if focusing on the choice between LRT and BRT. Studies categorised as positivistic/descriptive typically pose "what is best" type of questions. Such studies are making nomothetic, i.e., general knowledge claims on effects (e.g., transport function, transport economy, and different aspects of urban development) related to the choice of transport technology. One epistemological challenge identified concern how to measure impacts of public transport investments outside the transport system.

In the studies categorised as hermeneutic/interpretative, "Why" type of questions is generally posed. These studies make ideographic knowledge claims, although there are some tendencies to implicit, nomothetic ambitions. The results in several of these studies emphasise the dichotomy between LRT as an urban development strategy and BRT/buses as transport system tactics for moving people from A to B, although there is not any clear, substantial evidence to the validity of these results. This points to an epistemological challenge with such knowledge claims.

Studies focusing on "what is best" type questions tended to find that BRT is the rational choice, based various metrics commonly used in transport economics, engineering, and quantifiable aspects of urban development. Studies posing "why" type questions report that decision-makers highlight LRT as a strategic tool for urban development, in contrast to buses, which are often viewed as merely transport infrastructure projects.

What kind of knowledge claims about the choice of urban public transport technologies (track-based or road-based) are made in planning practice?

The results from the case studies—BRT in Helsingborg, and LRT in Lund—show that that urban development was an important factor in both cases; although the two cases exemplify somewhat different types of urban development.

In Lund, development can be characterised as a combination of large scale "green field" development of a new area of the city, plus improving urban qualities in parts of the route characterised by "fragmented urban space". Arguments about improving urban qualities along the suggested route place emphasis on choosing a technology with low level of noise, green areas, and less frequent departures. The impact of the overhead contact lines, poles, and the tracks were forwarded by opponents to the project as negative for urban qualities in the part of the corridor traversing the historical centre of Lund—this conception of (conserving) urban qualities became part of the arguments against LRT (and an argument for electric buses).

In Helsingborg, the urban development perspective also played an important role in advocating for an upgrade to BRT. The perceived flexibility of bus routes was viewed as positive due to uncertainties about future development strategies of the city. Since it was

unclear where to concentrate new development, and how to service future development areas, a BRT solution was viewed as suitable. Another important urban development aspect in Helsingborg was the expectation that the BRT system should contribute to improving social conditions and the image of peripheral areas in the Northeast part of the city.

Drawing on the findings of the two case studies, I conclude that moving people from point A to point B was not the sole purpose behind the upgrades. Urban development rationales—albeit different types of urban development rationales—played key roles in both cities in terms of justifying the choice of transport technology.

When it comes to transport function, key arguments in Lund concerned the choice of technology allowing for a high-capacity system with "reasonable" vehicle speeds in development areas, and "acceptable" intrusion/consequences for other transport modes in the city. Based on these criteria for determining capacity needs, combined with the projections of growth of inhabitants in the developing areas, and projections of passengers on the route, LRT became the only option that met the requirements.

In Helsingborg, level of service, and especially right of way, were at the centre of a key conflict concerning system design, pertaining to the parts of the bus route traversing the city centre. Here, the negative consequences for car users of proposed median-aligned bus lanes, eventually resulted in design choices using curb-aligned busways through the city centre—the result of which is a lower level of right of way, and lower priority for buses compared to the alternative with median-aligned lanes. This highlights that the flexibility of buses can result in design choices characterised by compromises.

Are the knowledge claims in research and in planning practice consistent, or are there any major discrepancies?

By juxtaposing the results from the analysis of knowledge claims in research with the analysis of the knowledge claims in the case studies, I have identified three discrepancies. Below these discrepancies are discussed as fallacies—either found in in research or in decision-making practice—which imply risks that the debate about the choice between road or track is skewed.

- **The urban strategy versus transport tactic fallacy**
  Based on the findings of the two case studies I argue that the narrative of the dichotomy between LRT as an urban development strategy and BRT as transport system tactics found in some research is too simplistic. In both cases it was clear that urban development objectives and discussions about the impacts of the choice of transport technology has on different aspects of urban development played an important role in the debates about which transport technology to choose when upgrading the public transport system. In both case studies, both improving various aspects of urban qualities and addressing concerns that clearly fell beyond the technical configuration of the public transport system in itself were important.

- **The capacity fallacy**
  The results of the study indicate that there may be an inherent conflict between the argument that BRT systems can have the same, or a higher capacity than track-based modes, while at the same time also offering the potential to play the role of an urban

(re)development instrument. The conflict lies in that the theoretical capacity of BRT depends on high operational speeds and frequent departures; i.e., a high level of service and high capacity means driving a lot of buses at high speeds on segregated busways. This can be viewed as problematic from an urban development perspective, and highlights a contradiction between frequency of services and improving urban qualities of an area. From a transport research perspective, services with high frequencies and high speeds are positive (and bring benefits, such as time savings for the passenger); but from an urban development perspective, lower frequency and more moderate speed (given the same capacity) may be preferred. Additionally, lower frequency of public transport in main transport corridors will have less impact on other traffic flows (e.g., car traffic, but also bicyclists and pedestrians).

- **The flexibility fallacy**
  The concept of flexibility has different connotations depending on perspective. It can be viewed as a positive trait for road-based services, compared to the "rigid" nature of track-based systems. I do, however, argue that in order to achieve BRT qualities, especially right of way, flexibility has to be diminished, and public transport corridors require the same infrastructure characteristics regardless of mode. The flexibility fallacy is therefore also linked to a misconception about BRT, where the public debate sometimes seems to focus only on the vehicles. This misconception contributes to a risk of over-estimating the differences in costs between track-based and high-quality road-based systems.

  From an urban planning perspective, the fixed nature of track-based systems is also viewed as important in order for public transport systems to function as stable planning elements structuring urban development. In addition, the perceived flexibility of buses can make it harder to implement key measures of bus priority, which results in solutions characterised by compromises and a lower standard than what had initially been planned.

The analysis identified some challenges that can inform future research. This includes a poor understanding of urban development within transport research, and a tendency bundle multi-faceted concepts, such as "urban development" and "urban qualities" into simplifications—e.g., by using increases in housing prices as a proxy for "urban development" potential, or misconceptions about BRT as merely transport system tactics for "moving people from point A to point B". Essentially, this boils down to the question as to whether LRT, as a mode, really has intrinsic qualities that make it superior to BRT from an urban development perspective.

In order to improve the understanding of the roles played by the choice of public transport technology for achieving different "urban qualities" and urban development objectives, a fruitful trajectory could therefore be research designs combining transport research perspectives with perspectives from disciplines such as architecture and urban planning.

1. Introduction

Many mid-sized to large cities struggle to provide efficient and attractive sustainable transport systems for main urban and regional corridors. Typically, the necessary requirements for such transport systems are that in order to compete with the car, the choice of technology must allow for high capacity, high frequency and competitive travel speeds in a prioritised network (Nielsen et al., 2005; Bruun et al., 2018). While metro systems meet all these requirements with the added benefit of not intruding too much into above-ground urban space, the massive construction costs restrict the plausibility of building such systems apart from in very big and highly affluent cities. In many cities, the viable options are therefore restricted to surface-level high-capacity transport technologies.

The main competing technologies available to supply such qualities are either track-based, such as trams or light rail (LRT), or road-based, such as buses with high levels of service (BHLS) or bus rapid transit (BRT) (Finn et al., 2011; ITDP, 2017).[1] From the perspective of transport research, there have been several studies comparing the performance of track-based and road-based systems (e.g. Vuhic, 2000; Hodgson et al., 2013). In general, benchmark studies have shown that road-based solutions can supply the same capacity as track-based systems at a lower investment cost (Kain & Lui, 1999; Vuhic, 2000; Hodgson et al., 2013; Nikitas & Karlsson, 2015; Munoz & Paget-Seekins, 2016; Ingvardsen & Nielsen, 2017). Despite this, there are plenty of examples of where decisions to build track-based systems have been made (see e.g., Henscher, 2007; Hodgson et al., 2013; Olesen & Lassen, 2016).

The apparent conflict between transport professional appraisal— the results of which in many cases have been "pro-road" and "pro-track" political decision-making—may have multiple potential explanations. This includes the fact that benchmark studies are typically restricted to the appraisal of transport-related aspects, such as capacity, travel time savings, and investment and operation costs; whereas political decision-making will also be based on other types of effects occurring, or that decision-makers expect will occur, as direct or indirect consequences of system choice. Some examples of such effects could include overall public trust and political support, land use and urban development, the attraction of private investors, and the influence of strategic policy versus short-term interests in future transport planning decisions. De Bruijn & Veeneman (2009), for instance, concluded that BRT systems lack the mythical 'allure' often linked to LRT which can help mobilise political support from various actors involved in the process. Olesen & Lassen (2016, p. 10) emphasise the importance of "… discourses such as 'the struggle for space', 'the backbone of the public transport network', [and] 'the image of the city'…" as key explanations in the choice of transport technology. Johansson et al.

[1] I am aware that there are many technical distinctions between different road- or track-based systems, but for the purpose of this report such details are not necessary. Throughout the rest of the report BRT is used as an acronym for high quality road-based systems, and LRT is used as an acronym for track-based systems.

(2019) highlighted that decision-makers harboured a preference for LRT.; a preference linked to the view of LRT as a strategy-driven investment driven by a desire to achieve an increase in housing construction (Johansson et al., 2019).

Similarly, Olesen & Lassen (2016) maintain that French LRT investments should be understood not as transport projects per se, but rather as strategic urban redesign projects where consideration of favouring softer transport modes, the creation of new urban spaces, and aesthetics have been central. It is, however, unclear exactly why LRT is perceived as superior to BRT for achieving strategic urban development and/or redesign ambitions.

There is a tendency in some of the literature (e.g., Olesen & Lassen (2016)) to view BRT as a transport project, while LRT is perceived as part of a wider strategic ambition related to urban development. However, this division is—at least to some extent—somewhat arbitrary. In the literature on BRT planning and implementation, there are many examples of BRT projects that were intimately linked to ambitions going beyond just transporting people from point A to point B. This includes restructuring, and attempts at formalising informal public transport sectors in Latin American and African cities (see e.g., Muñoz & Geschwinder, 2008; Ventel, 2013; Poku-Boansi & Marsden, 2018), but also urban development ambitions, among which the BRT in Curitiba is the most prominent example (see e.g., Duarte & Ultramari, 2012). There are also many other examples of where the rationality behind BRT has involved strategic urban development ambitions, but where, according to some commentators, these ambitions have failed to materialise. Interestingly Cervero & Dai (2014, p.134) explain this failure by explicitly contrasting transport planning and land-use planning rationalities: "Experiences in Bogotá and Ahmedabad suggest the failure to leverage compact, mixed-use development near stations stems from BRT systems being viewed mainly as mobility rather than city-shaping investments. In both cases, engineering, cost-minimizisation principles generally won out over urban-planning, development-maximizisation ones." What Cervero & Dai (2014) suggest, therefore is that the framing of the project, and the dominant principles applied in the planning process, could be more important than the choice of transport technology.

The results from the studies described above highlight the fact that politicians and other key decision-makers can have frames of reference guiding their decisions that are significantly wider than what existing transport research appraisal frameworks currently cover (Olesen, 2014). This could indicate that for a number of potential consequences that decision-makers find important, there is a lack of relevant and substantiated knowledge concerning the effect of system type choice. Other possibilities include that this knowledge exists in research, but decision-makers are not aware of it, or that the knowledge exists, but decision-makers choose to disregard it.

The purpose of this study is to compare, contrast, and critically examine knowledge claims in research and in decision making on the choice between track-based or road-based urban public transport systems.

The study comprises two main elements. First, an integrative literature review is performed to identify knowledge claims made in research, with emphasis on how knowledge is produced about the choice of transport technology, and which models or theoretical perspectives have been applied in different fields of research. The second part of the study is a comparative case study of two Swedish cities: one (Helsingborg) where

BRT has been built and one (Lund), where LRT has been built. These case studies were conducted to identify knowledge claims in planning practice.

In the report the following research questions are posed:

What kind of knowledge claims about the choice of urban public transport technologies (track-based or road-based) are made in research?

What kind of knowledge claims about the choice of urban public transport technologies (track-based or road-based) are made in planning practice?

Are the knowledge claims in research and in planning practice consistent, or are there any major discrepancies?

The report is structured as follows: Chapter 2 presents the method consisting of a combination of an integrative literature review and two case studies. In Chapter 3, knowledge claims in the literature are presented, and in Chapter 4, the knowledge claims in the case studies are presented. In Chapter 5 the results from Chapters 3 and 4 are compared, and three fallacies are suggested, and in Chapter 6 conclusions are drawn.

2. Method

The method in the study comprises two components:

- An integrative literature review of knowledge claims in research
- A comparative case study of two Swedish cities: Helsingborg, where BRT has been built; and Lund, where LRT has been built.

2.1. Integrative literature review

The aim of the literature review is to provide an overview of how publications in different academic fields (including, but not limited to transport engineering, transport economics, urban planning studies, real estate studies, and political science) have approached the issue of choosing transport technologies. The approach is in line with what Snyder (2019, p. 335) refers to as an "integrative literature review"; the purpose of which is described as to "[…] assess, critique, and synthesize the literature on a research topic in a way that enables new theoretical frameworks and perspectives to emerge." Snyder (2019) further states that an integrative literature review is well-suited to provide an overview of the knowledge base of a certain topic. This makes it possible to critically analyse and examine both the literature and the main ideas and relationships of an issue. Furthermore, the integrative approach can allow us to reconceptualise and expand on the theoretical foundation of a specific research topic.

The point of departure for the integrative literature review is in line with Åsberg (2001), who argues that the question of what kind of knowledge we produce through our research needs to be discussed free from the misleading rhetoric and inhibition of the quantitative–qualitative argument. The main focus of the literature review is to identify how knowledge is produced in different research traditions, and to identify knowledge claims made in a multi-disciplinary approach to decision-making processes. I define the multi-disciplinary approach as one that allows for combining the viewpoints and methods of several academic disciplines or professional specialisations. The literature review provides an overview of existing approaches (methods and theories) to acquire knowledge of effects, as well as an overview of knowledge gaps.

2.2. Comparative case study

The literature review provided input to the comparative case study of two Swedish cities (Lund and Helsingborg) which have chosen different transport technologies (LRT and BRT, respectively). Based on the findings from the literature review, an interview guide was developed that probed into the knowledge claims underpinning the decisions made

in terms of the choice of transport technology in each city. A total of seven interviews were conducted—four in Lund and three in Helsingborg—which included key decision-makers, such as senior officials and politicians centrally involved in the decisions on which technology to choose. In addition, key policy and planning documents were analysed.

Table 1. Case study Interviewees

Interviewee	Case	Role/organisation
Interviewee 1	Lund LRT	Politician/Lund municipality
Interviewee 2	Lund LRT	Senior official/Lund municipality Technical department
Interviewee 3	Lund LRT	Senior official/Lund municipality Technical department
Interviewee 4	Lund LRT	Senior official/Lund municipality Urban planning department
Interviewee 5	Lund LRT/Helsingborg BRT	Senior official SPIS (collaboration organisation LRT)
Interviewee 6	Helsingborg BRT	Politician
Interviewee 7	Helsingborg BRT	Senior official/Helsingborg municipality
Interviewee 8	Helsingborg BRT	Senior official/Skånetrafiken Regional public transport authority

3. Knowledge claims about the choice of urban public transport technologies in research

The main focus of the literature review was to identify how knowledge is produced regarding the choice of transport technology, and which models or theoretical perspectives have been applied in different fields of research.

The papers in the review (see Table 2) were selected through snowball sampling. The ambition was not to review all relevant literature; I instead opted to start with some portal literature focusing on the choice of track or road. These publications were used to identify other interesting references, and in total I ended up reading and reviewing 11 publications, all of which were published in peer reviewed academic journals, as book chapters, or in conference proceedings.

Table 2. Publications included in the literature review.

Title	Authors (year of publication)	Published
City boosterism and place-making with light rail transit: A critical review of light rail impacts on city image and quality	Ferbrache & Knowles (2017)	Geoforum
Sustainable public transportation systems: Moving towards a value for money and network-based approach and away from blind commitment	Henscher (2007)	Transport Policy
Exploring comparative ridership drivers of bus rapid transit and light rail transit routes	Currie & Delbosc (2013)	Journal of Public Transportation
Effects of new bus and rail rapid transit systems—an international review	Ingvardson & Nielsen (2017)	Transport Reviews
Appraisal of a regional public transport project: A document and interview analysis on a light rail case in Sweden	Johansson et al (2019)	Case studies on transport policy
Choosing the right public transport solution based on performance of components	Bruun et al (2018)	Transport
Rationalities and materialities of light rail scapes	Olesen & Lassen (2016)	Journal of transport Geography
Decision-making for light rail	Bruijn & Veeneman (2009)	Transportation research part A
Can bus really be the new tram?	Hodgson et al (2013)	Research in transportation economics
Framing light rail projects —case studies from Bergen, Angers and Bern	Olesen (2014)	Case studies on transport policy

For the review, three broad analytical categories of publications referring to their general disciplinary orientation were constructed; transport economics, transport functionality, and urban development.

Papers were allocated to the three different categories based on the aspects and perspectives to which they referred, or were captured in the analysis, including statements about how these aspects speak for road and track-based solutions. The category transport economics" includes papers focusing on issues such as investment costs, benefits for users (e.g., time savings, costs, comfort, etc.), and operational and maintenance costs. The category "transport functionality" includes papers focusing on transport engineering issues, such as commercial speeds, right of way, level of service, and headways. The category "urban development" includes a broad palette of issues spanning from impacts on real estate prices and other types of effects on urban development, to papers focusing on decision-making processes and the influence of local planning and politics on the choice of transport technology.

These categories should be seen as broad analytical constructs, and the boundaries between the categories should be seen as floating rather than clearly defined. This means that a publication can be included in more than one—or indeed in all three—categories. The categories were used to position and group the publications relative to each other. In the account below I use the three categories to discuss the type of knowledge produced in each publication.

In addition to categorising the reviewed papers according to topics and broad disciplinary relevance, I also distinguish between idiographic and nomothetic approaches to knowledge claims made in the papers. Ideographic approaches to knowledge are characterised by aiming to shed light on individual, unique events. Nomothetic approaches to knowledge seek as general knowledge claims as possible (Åsberg, 2001). In line with Åsberg (2001), I also argue that nomothetic approaches to knowledge often are linked to ambitions to explain causality, while idiographic approaches to knowledge acquisition are linked to hermeneutic approaches based on interpretation.

The nomothetic or ideographic approach to knowledge depends on ontological and epistemological points of departure. Drawing on Åsberg, (2001) I will categorise the reviewed literature in two main categories based on ontological and epistemological points of departure:

(i) Studies with a positivistic, descriptive approach to knowledge.

(ii) Studies with a hermeneutic, interpretive approach to knowledge.

3.1. Knowledge claims in studies with a positivistic, descriptive approach

All of the papers in this group mainly rely on quantitative data and focus on transport economy and transport function, although there are examples (e.g., Currie & Delbosc, 2013; Ingvardson & Nielsen, 2018) that also address aspects of address urban development. Many of the papers are either implicitly or explicitly normative, and make claims to nomothetic knowledge with the ambition to provide answers about what is the

best option, and addressing questions such as: how are, and how should projects be appraised? What counts as evidence of 'good' or 'bad' performance? How can performance be measured and compared?

3.1.1. Benchmarking BRT versus LRT

Henscher (2007) is an example of a paper conflating the transport economy and transport function perspectives. Key questions in the paper concern how to conceptualise which alternative (BRT or LRT) offer the best value for the money. There is little doubt about the opinion of the author who states that the "…paper is designed to reinforce the appeal of BRT systems over other public transport strategies." (Henscher, 2007, p. 101)

The paper is categorised as a topical issue paper, and therefore there is no explicit method described. The argumentation in the paper draws on results from various ex-post benchmark studies from different parts of the world. A main focus in the paper is on highlighting the advantages of BRT over LRT (and other forms of urban rail investments) based on performance evidence concerning transport function characteristics: (e.g., capacity at system level as opposed to capacity at the vehicle level). A key result in the paper is that BRT can outperform LRT, and many examples are given of BRT systems with higher capacity than LRT.

Another key argument in the paper concerns value-for-money. It is concluded that costs (including both investment and operating/maintenance) are lower for BRT, and since BRT capacity performance is equal, or greater than for LRT, a general conclusion is that BRT offers the best value for money. The argumentation also touches on other issues such as "civic appeal" (as a driving force for political will), and the potential of structuring effects of BRT. Henscher, (2007, p. 101) states that "BRT can stimulate the development or re-development of compact, pedestrian- and transit-friendly land uses, when supported by complementary land use and zoning policies."

Hodgson et al. (2013) is an example of an ex-ante modelling study with input from various BRT and LRT systems in operation. The focus of the paper is on transport function and transport economy. The authors highlight that in the UK's transport policy context, the requirements for BRT to address the needs are somewhat different than in the Latin American context (where the concept of BRT originates). In the UK, the emphasis is on the possibility of designing high quality bus services that can contribute to shifting car users to public transport. According to Hodgson et al. (2013), this means less focus on capacity and more focus on quality aspects.

In the paper an "equivalence model" is applied to compare performance levels regarding costs (both capital expenditure for investments in infrastructure and vehicles, and operating costs), and environmental impacts (CO_2, PM_{10}, and NO_x). A key result from the study is that if a BRT service is designed with high-specs (i.e., similar right of way and priority as LRT), it is possible to achieve the same performance levels as LRT with 30% lower capital cost. Operating costs are similar, as is CO_2 emissions. BRT has lower PM_{10} emissions, but higher NO_x than LRT.

3.1.2. Understanding the role of mode versus context

Bruun et al. (2018, p. 1017) aims "…to promote a more mode-neutral approach to the selection of PT investment packages." The question they seek to unravel is what is attributable to the choice of mode, and what is attributable to the site of implementation? The authors argue against starting with a pre-defined solution (i.e., LRT or BRT) that constrains the definition of the problem, and to instead allow for an unbiased process of selection.

The paper is an example of a study focusing on transport function and transport economy, but the paper also contains a discussion concerning issues relating to urban development (such as local/regional goals and ambitions including the time frame for implementation, equity, risks, aesthetics, and funding). However, the main emphasis is on "unpacking the trade-offs between the principal components of a PT system"; i.e.,, cost, capacity and right-of-way". (Bruun et al., 2018, p.1023). Key conclusions include that vehicle technology (track-based or road-based) is of less importance than alignment characteristics, particularly right-of-way and stop spacing. These two characteristics have more influence on average operating speed (and thereby operating costs) than the choice of mode.

Ingvardson and Nielsen (2017), is an example of a study addressing transport function and urban development. The aim of the study is to fill a gap in the current literature where studies either focus on the effects of BRT, LRT, or heavy rail. The methodological approach can be described as an ex-post comparison of effects on changes in demand/modal shift, changes in property value, and impacts on city development. The study is based on a sample of data from 86 public transport systems from around the world, covering a span from BRT via LRT to heavy rail/metro.

One key finding from the study is that the authors conclude that there is a clash between cost efficiency/high average operating speed and "urban development ambitions". For BRT it can be difficult to combine short travel times and improved urban areas, due to high class BRT requiring a lot of surface space (compared to metro). Ingvardson & Nielsen (2017) also state that no significant differences in effects can be found directly attributable to the public transport mode in itself. Instead, the authors conclude that "…impacts depend more on the extent to which the system improves the existing situation, the competition with car traffic and how the system is implemented in the local context." (Ingvardson & Nielsen, 2017, p. 110)

Ingvardson & Nielsen, (2017) also discusses the epistemological challenges of comparing effects on urban development. This includes a lack of consistent definitions of what impacts to include in urban development effects (such as urban regeneration, TOD, development, densification). There is also a lack of knowledge about dynamics between increases in property values in areas achieving improved accessibility versus housing price decreases along routes (e.g., due to noise and disturbances). The authors conclude that studies generally only focus on one issue, and there is a lack of substantiated knowledge about whether effects on property values are generative (i.e., they contribute to increasing values throughout an urban area) or distributive (i.e., increases in areas with improved accessibility are off-set by decreases in other areas). A further issue with comparing effects on housing prices based on data from many different studies is the lack of standardised methods.

Another study addressing transport function and urban development is Currie and Delbosc (2013). This study departs from the notion that a lot of research has focused on the relative costs of choosing between BRT and LRT, but that there is a lack of studies focusing on the comparative merits of respective mode in terms of what explains high patronage. So, it is another example of a study trying to answer "what is best" questions, but from a different perspective than the value-for-money approach exemplified in some other studies (e.g., Henscher, 2007). The aim is defined as to "…provide an objective base to determine whether the transit mode has a significant influence on ridership above and beyond other important variables such as service level or urban density" (Currie and Delbosc, 2013, p. 48).

The methodology in the paper can be described as an ex-post study based on regression analyses of data from various systems around the world including 44 BRT routes (AUS only), and 57 LRT lines (US, CAN, IRL, UK, FRA). The intention is also that the results from the study can be used to inform future ex-ante appraisals.

Some key findings in this paper includes that many important drivers of high patronage are exogenous to public transport systems. One example is that "being located in Europe" is identified as the most influential ridership driver, suggesting that European LRT achieves a considerable ridership bonus. The authors discuss possible explanations for this which include linkages between key characteristics of European cities being defined by "high pedestrianisation"; i.e., the design of urban fabric of European cities are often, due to historical reasons, pedestrian friendly compared to, e.g., cities in Australia or in the US. Another related factor is that European cities typically have a relatively high public transport modal share, which according to the authors reflects "network effects" and "scale effects, as well as employment density.

The authors conclude that the public transport mode is not a significant determinant of increasing patronage. (However, vehicle capacity is significant and a predictor of boardings per vehicle kilometre.) Integrated ticketing is also an important factor. And the authors conclude that low speed correlates with high ridership. The authors explain this by stating that the analysis merely highlights a correlation that can be expressed as "the higher the ridership, the lower the speed".

3.2. Knowledge claims in studies with a hermeneutic, interpretive approach

While the papers reviewed above all address topics relating to the choice of transport technology analysing quantitative data, we will now turn to a body of literature that approaches the decision of transport technology from hermeneutic, interpretative perspectives. The studies reviewed here are focused to a lesser extent on answering "what is best" type of questions (although such questions are discussed, implicitly or explicitly, in some of the papers). The papers reviewed here are more concerned with understanding the rationale behind choosing a specific type of technology and seeks to answer questions about how projects have been appraised, and what kind of visions or rationalities were behind the choice to build a specific project.

3.2.1. How are projects appraised?

Johansson et al (2019) is one example of a publication categorised as belonging to the transport economics category. The authors' position the paper as being "…about the planning and ex-ante appraisal of public transport investments in Sweden" (Johansson et al., 2019, p.196), and the topic of the study is the planning process of a LRT project in Stockholm. The purpose is described as "…to elaborate on the use of appraisal tools; i.e., the kinds of tools employed and at what stage they enter the planning process." (Johansson et al., 2019, p196). The method in the paper combines document analysis of various planning documents with interviews with planners.

A key conclusion of the paper is that the choice of transport technology was settled before any appraisal studies had been made. Subsequent results of appraisal studies (both cost-benefit analyses and multi-criteria analysis) during the decision process showed that the proposed LRT performed poorly. Johansson et al. (2019) also highlighted that there was a strong reluctance to even include a BRT alternative in the appraisal process. Additionally, even though the BRT proposal performed better in the appraisal, the support for building LRT remained unaltered. Here the explanation seemed to be that the decision-makers harboured a preference for LRT as a solution. This is a preference linked to the view of LRT as a strategy-driven investment driven by a desire to achieve an increase in housing construction (Johansson et al., 2019).

3.2.2. Understanding ideas, visions and rationalities

Olesen (2014), and Olesen & Lassen (2016) are two examples of studies focusing on improving the understanding of ideas, visions and rationalities behind LRT projects in European cities (Bergen, Norway; Angers, France, and Bern, Switzerland). These studies can be described as ex-post case studies of the decision-making process. The data in the paper consists of interviews with decision-makers, document analysis, and observations, such as walking along and riding the LRT routes. In Olesen & Lassen (2016) the data is analysed with a theoretical framework based on "mobilities research" (e.g., Urry, 2000) focusing on rationalities and materialities of light rail scapes (consisting of "hardware" such as trains, tracks and stations; as well as "software", such as politics, metaphors and rationalities. (Olesen & Lassen, 2016: p.374). Olesen (2014: p.11) applies a similar approach, also exploring "…why light rail is chosen and the rationalities behind these decisions and the effects that these frames for light rail mobility have had."

Olesen & Lassen (2016) analyse the discursive framings justifying the choice to build LRT in Bergen and Angers and highlight that the interviewees and planning documents emphasise that the choice in both cities go beyond performing a transport function, and that this framing influences design choices that highlight trade-offs between emphasis on transport function/economy versus urban development ambitions. Indeed, Olesen & Lassen (2016) show that the LRT project in Bergen was first developed according to transport planning principles using high operational speed and travel time savings as key parameters. This approach necessitated large parts of the system to operate on segregated, grade-separated infrastructure. Later on, the project was reframed as an urban development project, which meant less emphasis on operational speed and travel time savings, and more emphasis on creating conditions for urban development. In none of the cities was BRT part of the appraisal process. Similarly, in Angers, the emphasis on using

the LRT as a tool for redeveloping the city meant that alignment characteristics and close proximity between stops meant that the operational speed of the LRT was on average 18km/h (in Bergen the average speed is 28km/h). The interviews in Angers showed that LRT was decided on from the start, and that the mayor of the city had a strong preference for LRT was the main reason for this. The Angers project highlight that choices regarding design (e.g., the construction of a new bridge) strongly favoured aesthetics above costs. The Angers LRT was costly—approximately 300 million € (in 2005). Olesen & Lassen (2016, p. 381) conclude that both cases illustrate that "…the choice of specific corridors by politicians and planners requires at the discursive level, many other rationalities versus simply moving people from point A to B as efficiently as possible." Similarly, Olesen (2014, p. 17) conclude that "…there seems to be a double rationale present in all projects: upgrading the public transport network and supporting urban development and regeneration."

Olesen & Lassen (2016, p. 381) write about Angers that "…the light rail was defined by a re-design vision and reclamation of public spaces for softer modes. This vision materialised in a light rail scape where design and materiality support the redesign and development of central districts along the corridor. Districts that are socially and physically diverse have been given the same visual and physical priority through the design of the new light rail corridor. The light rail acts as an icon of modernity and mediates the locale's identify and culture."

3.2.3. LRT and city image

Ferbrache & Knowles (2017) depart from the notion that LRT projects can play an important role in boosting the image of cities, and they seek to unravel how LRT can be understood as part of place-making strategies. They argue that "through a cultural geographic lens and conceptualization of space as socially constructed, light rail can be understood as part of place-making strategies that help to rejuvenate individual streets, (re)produce urban spaces and, in turn shape discourses about the city and its image." Ferbrache and Knowles (2017, p. 103) The aims of the paper are defined as: "…i) to explore a cultural geographic perspective as a way of conceptualising the relationship between LRT development and city boosterism; (ii) to evaluate existing empirical evidence in terms of what it reveals about (mainly) ex-post impacts of LRT on city image and quality; and (iii) to identify gaps in LRT literature and provide directions for future research" (Ferbrache & Knowles 2017, p. 103).

The method in the paper relies mainly on qualitative data to synthesise and critically review findings in existing LRT literature. The authors argue that this is in response to Hensher's (2016) critique of "emotional ideology" in decision-making favouring LRT.

Ferbrache & Knowles' (2017) results include a linkage between viewing the city as modern (describing the city using the word modern, and similar words) and using the word modern to describing LRT as a modern form of public transport. This emphasises that public transport systems are expected to be aesthetically pleasing, in order to symbolise an up-to-date urban transport system fitting for a 21st century city that cares about its image. Arguments found in policy documents include that LRT ensures cities a right to play in the big league, and arguments about LRT as a key component to bolster growth. Ferbrache & Knowles (2017) found no published evidence to support such

claims, but they argue that based on what is written about LRT in policy documents, there is general evidence that LRT can be an agent in broader urban development agendas. The authors do, however, conclude that it is difficult to isolate the impact of LRT on place-making from other changes; e.g., housing and business development, and improvements in pedestrian infrastructure.

Ferbrache & Knowles (2017) also address differences between LRT and BRT. An obvious and well-known trope found is the conception of LRT as fast, clean, and stylish compared to antiquated, slow, dirty, and uncomfortable buses. But there is also some evidence that BRT can match image qualities of LRT (especially when users have direct experience of BRT). However, Cain and Flynn (2013) argue that the image of surrounding urban areas themselves have greater impact on image than the technology of the public transport system.

3.3. Discussion and conclusions from literature review

The integrative literature review was conducted to answer the question: what kind of knowledge claims about the choice of urban public transport technologies (track-based or road-based) are made in research?

A main observation is that there are few examples of studies explicitly focusing on understanding the choice of transport technology, at least if focusing on the choice between LRT and BRT. That being said, many, if not all, of the reviewed papers are covering topics of relevance for making decisions on the choice of technology.

Based on the reviewed papers, we can start by comparing the knowledge claims made in studies with a positivistic/descriptive approach. The papers reviewed in Chapter 3.1 include many examples of positivistic research linked to all three areas (transport economics, transport functionality, and urban development). In general, the aim of these papers is to generate knowledge based on numbers which means that focus is directed to effects and impacts that can be measured. The knowledge claims (implicit or explicit) in these papers are typically nomothetic, in that they seek to arrive at as general a level of knowledge as possible (Åsberg, 2001). The results are expected to deliver knowledge that provide decision-makers with input of how to make sure investments are "the best solution." This type of research is clearly in line with a traditional rationalist approach to transport planning, described by Portinsson Hylander (2021) as defined by the pursuit of a positivist approach to planning, in which a central problem is to distinguish responsible decisions from ill-founded ones.

Among the review papers, quantified knowledge claims concerning transport function and operational economics are most prominent. There are also several examples of quantified knowledge claims concerning urban development, normally by focusing on impacts on property value. Here we can note that the perception of "what is best" follows from the ontologies of theoretical approaches, and methods in the studies.

To exemplify, the transport function ontology places emphasis on issues such as capacity, level of service, and commercial speeds and it is assumed that higher performance is better. The ontology of transport economics put emphasis on travel time savings as the

main priority and a key proxy for understanding the value of an investment in relation to its cost. As was shown in the literature review, research on transport function or transport economy often declares BRT as the rational, and "best" choice. Urban development ontologies—e.g., measuring the impact on property prices—means that the point of departure is that increases in property values are viewed as intrinsically positive. Regarding effects on property values in relation to the choice of technology, there is a less clear verdict in the literature here categorised as positivistic/descriptive.

Based on the review I argue it is possible to identify some epistemological challenges in research here categorised as positivistic/interpretative, where there is a difference depending on which of the three perspectives we choose to focus. Studies focusing on transport function and transport economy rely on methods which benefit from being standardised and rest on a substantial body of research. The epistemological challenges in this type of research are quite well-known; e.g., at what point in time to make evaluations, how reliable is the data, etc. However, there are a number of well-established concepts, and these concepts are closely related to the methods that are employed, which increases the potential of generalisable/transferable results from one context to another.

In contrast, the epistemological challenges when attempting to quantify effects on urban development are greater. Here challenges include what to measure; e.g., what is actually meant by urban development, what types of concepts to use to capture various dimensions of urban development, and how to measure impacts on urban development specifically linked to the choice of transport technology? Additionally, a key question is whether the measures used in research correspond to what decision-makers want to know, or whether the measures are chosen because of their utility. One case in point is that property values are used as the main proxy for measuring impacts of public transport investments. This choice relies on an ontological assumption that increased property values are beneficial and that investments in public transportand the increased accessibility of certain location this creates—should increase property values.

As shown in Chapter 3.2, the papers categorised here as having a hermeneutic/interpretative approach exemplify a different type of research. Here ideographic approaches to knowledge based on case study research designs aiming to shed light on individual, unique events are typical. The data in these studies often comprise a combination of interviews with decision-makers and policy documents. Analyses are typically based on the application of theoretical/analytical frameworks; e.g., mobilities, and light rail scapes as exemplified by Olesen (2014).

The clearest pattern emerging among the papers categorised as hermeneutic/interpretative is to position the choice between BRT/LRT as a matter of whether it is "simply" a transport project, or part of a wider urban (re)development scheme. This juxtaposition, highlighting trade-offs between emphasis on transport function/transport economy versus urban development ambitions, is present in all studies in the hermeneutic/interpretative tradition.

Both Olesen (2014) and Olesen and Lassen (2016) are trying to improve the understanding of why LRT is chosen, but this is not the same as saying that the studies are focusing on the choice between road or track. While some discussions about considerations of road-based options do occur, it is not a prominent feature of the studies. This is partly due to the timelines of the projects (genesis dating back to 80s and 90s, i.e.,

before the proliferation of BRT as a transport policy concept outside of Latin America). Arguably, the analytical approach of the authors also restricts the usefulness of the studies for understanding to what extent alternatives where considered. Since the point of departure is understanding why LRT was chosen, there is a tendency, and perhaps also a risk, that the results of the studies uncritically buy into the narratives of policy documents and interviewees that promulgate the dichotomy between LRT as a broader urban development strategy versus BRT as transport system tactics for moving people from point A to point B.

I would argue that the papers reviewed here highlight an epistemological challenge with this type of research. The knowledge claims here can be characterised as ideographic—where attempts are made to reach analytical generalisability from case study research. This is not in itself remarkable, as it follows the standard approach for conducting this type of research. However, there may be a paradox in applying this type of ideographic approach, stressing the uniqueness of cases and their contexts, and arriving at attempts at (general?) explanations as to why a specific technology was chosen, as exemplified by the urban development strategy versus transport system tactics narrative described above. In addition, this highlights a criticism of hermeneutic knowledge claims previously forwarded by e.g., Habermas (1973), where hermeneutics naively assesses conditions according to how they are subjectively perceived.

In summary, the studies categorised as positivistic/descriptive typically pose "what is best" type of questions. Such studies are making nomothetic knowledge claims on effects (e.g., transport function, transport economy, and different aspects of urban development) related to the choice of transport technology. One epistemological challenge identified concern how to measure impacts of public transport investments outside the transport system.

In the studies categorised as hermeneutic/interpretative, "why" type of questions are generally posed. These studies make ideographic knowledge claims, although there are some tendencies to implicit, nomothetic ambitions. The results in several of these studies emphasise the dichotomy between LRT as urban development strategy and BRT/buses as transport system tactics, although there is not any clear, substantial evidence to the validity of these results (at least beyond the studied cases). This points to an epistemological challenge inherent to such knowledge claims.

4. Knowledge claims about the choice of urban public transport technologies in planning practice

In this chapter the results from two case studies in Southern Sweden are presented. In Chapter 4.2 the findings from the cases are discussed and contrasted.

4.1. The case studies

Lund (92,0000 inhabitants) and Helsingborg (113,000 inhabitants) are two cities located about 50 km from each other in Southwest Sweden in the region of Skåne. Both cities have experienced relatively strong and sustained population growth in the last couple of decades. In a regional perspective the two cities are "cores"; characterised by a concentration of workplaces and a large share of in-commuting from surrounding municipalities.

Both cities have made investments in recent years in the public transport systems. In Lund, the Lundaexpressen, a 5.5km LRT, was inaugurated in December 2020. In Helsingborg, the 11.7km-long BRT service, Helsingborgsexpressen, was deemed operational a year and half earlier.

Both cities, together with Malmö and the Region of Skåne (the regional public transport authority) were involved in an organisation called SPIS (*spårvägar i Skåne*). SPIS was established in 2010, and had 33 MSEK in funding from the European Investment Bank (EIB). The purpose of SPIS was to lobby for the implementation of LRT in the three cities. According to Interviewee 5, the funding was conditional on whether at least one of the cities committed to implementing LRT; otherwise the funding from EIB had to be repaid.

Both cities also received considerable state funding from national government policy initiatives such as the Urban Environment agreements, and the so-called "Swedish Negotiations."

The investment cost for Lundaexpressen, including infrastructure, vehicles and a service depot was 1,457 MSEK. The project was co-financed by the state, the region of Skåne, and Lund municipality. Cost for infrastructure amounted to 890 MSEK. The stated contributed 373 MSEK through Urban Environment agreements (75 MSEK), the Swedish Negotiations (298 MSEK), and Lund municipality 527 MSEK. The region of Skåne invested 297 MSEK in vehicles and 270 MSEK in a service depot (Lund municipality, 2023).

Helsingborgsexpressen was co-funded by the state, the region of Skåne, and Helsingborg municipality. The investment costs for Helsingborgsexpressen were 196 MSEK. The co-funding agreement stipulated that the city of Helsingborg was responsible for the infrastructure (building bus lanes, rebuilding streets, and building new and improved bus stops). Half of the investment costs for infrastructure were covered by state funds through the Urban Environment agreements. The region of Skåne, through Skånetrafiken were responsible for procuring an operator for the service. The contract specified that the operator was to purchase vehicles (electric buses), finance and install charging infrastructure for the buses, and operate the service (City of Helsingborg 2016, p.1). In addition, the municipal company "Öresundskraft" installed the necessary power grid upgrades for the bus depots, which were financed with access fees to the operator. As such, the contract with the operator included costs for the whole (electric) BRT concept not included in the 196 MSEK mentioned above (Interviewee 8, Skånetrafiken). Consequently, it is difficult to make direct comparisons of the costs between the two case studies, and they are beyond the scope of this report. It can, however, be concluded that investment costs for Lundaexpressen are far higher than those for Helsingborgsexpresssen.

In this section of the report, we provide background and different reasons justifying the choice of investment in each city. The account is based on data from documents and from interviews with key actors in each city.

4.1.1. LRT in Lund—genesis and justification

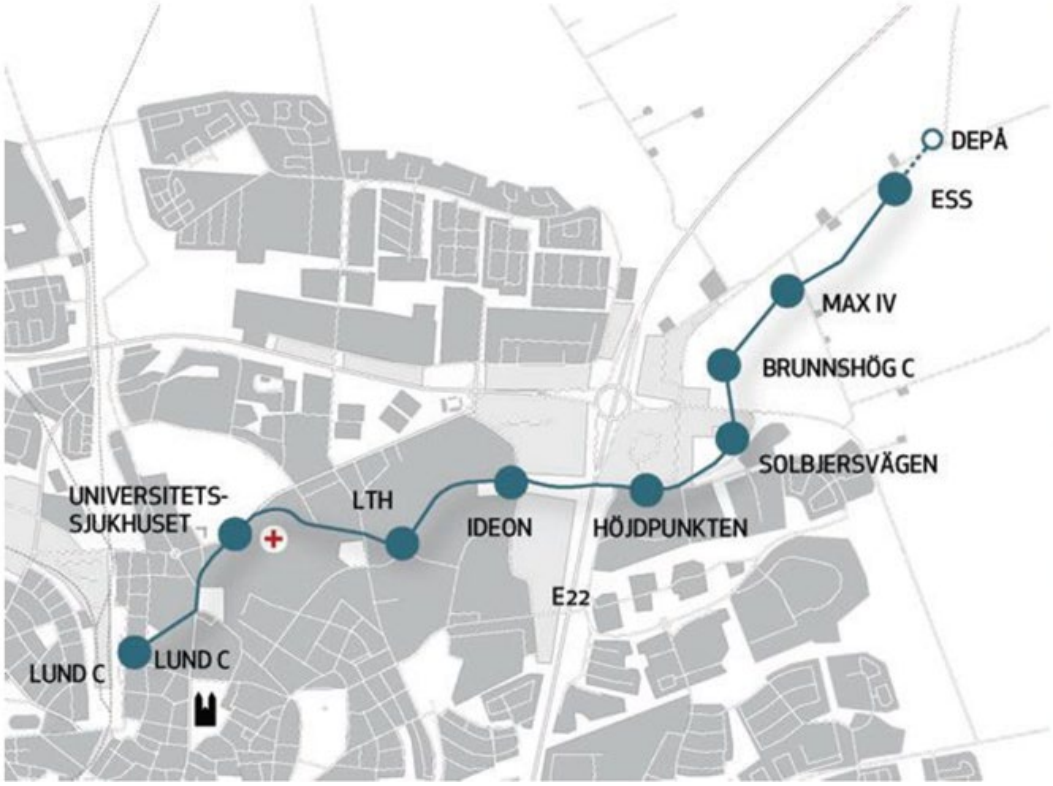

Figure 1. The planned Alignment and stops of the proposed LRT in Lund (Source: Lund Municipality, 2010)

> "Expanding the Lundalänken to a more complete BRT solution would mean an improvement in capacity in relation to the baseline alternative but also require extensive rebuilding of the urban environment, where especially the stop environments would be very large-scale. This is not considered appropriate in regard to the high urban environmental ambitions that exist for Lund NE/Brunnshög. A BRT solution is also not considered to be compatible with Lundalänken's planned stage expansion through the city centre to Southern Lund and Staffanstorp. This conclusion also applies if the BRT concept were to be operated by wire bus or electric bus." (Lund municipality 2010, p. xx) (translated by the author)

The citation from the 2010 comprehensive plan for Lund municipality highlights that even though the idea to build LRT in Lund dates back several decades, there have been discussions about road-based alternatives. However, the decision process in Lund is characterised by a strong commitment to LRT as the solution.

The idea to build a track-based public transport solution in Lund go back to the end of the 1980s. The discussions to build LRT in order to improve the local public transport resulted in a decision in 1989 to develop the five-kilometre-long bus route "Lundalänken" (Expertgruppen, 2015). The ambition was that Lundalänken should have a high level of right of way, and that buses using this route should have high priority. Lundalänken, which encompassed investments of several 100 million SEK for infrastructure upgrades (e.g., a grade-separated intersection, bus priority signals at intersections, and segregated bus lanes in some sections of the route), was inaugurated in 2003. Several of the interviewees, e.g., Interviewees 2, 3 and 4, point out that Lundalänken was viewed as the first step in improving the public transport system, to be followed by an upgrading to LRT.

According to Interviewee 2, a key reason that facilitated the investment in Lundalänken, as well as the subsequent plans for investing in LRT was that local decision-makers had a strong interest in environmental issues. Interviewee 2 explained that this interest followed from the Agenda 21 initiatives that asserted considerable influence on the discussions about urban and transport system development in Lund in the 1990s. This emphasis on sustainable transport resulted in the municipality adopting a local transport strategy, "LundaMats", which asserted considerable influence on planning (Lund municipality, 2014).

In parallel, local urban politics and planning was, according to Interviewee 2, characterised by a positive, growth-oriented outlook. The combination of the university and local businesses created favourable conditions for the creation of new jobs in "knowledge intensive" branches of the economy, and thereby an increase in population. Grand long-term visions for Lund to become a city of mounting importance, both regionally and nationally, were gradually developed during the 1990s and early 2000s.

A key aspect of the urban development visions for Lund was to expand towards the Northeast, where a greenfield area known as "Brunnshög" was identified as having the potential to house a substantial number of new inhabitants, as well as being the location for massive, strategic investments in research infrastructure (including both a synchrotron light facility, and a neutron spallation source). According to Interviewee 1, a key

challenge already being discussed at the outset was how to connect the new development area in Brunnshög with the existing parts in Lund without it feeling like a periphery. The corridor starting at Lund central station, via the hospital, parts of the university campus, a science park called "Ideon", and terminating at Brunnshög was to be called "the knowledge corridor". Interviewee 1 called this corridor structure, which aligned several important destinations in the local transport system between the endpoints at the central station and Brunnshög, "a fortunate coincidence". Lundalänken formed the basis of the knowledge corridor, and eventually the LRT would expand the route all the way to the new development areas of Brunnshög (see Figure 1). Politicians and planners agreed that the corridor should have the best possible public transport solution in terms of capacity, quality, and minimal environmental impact (Interviewees 1, 2, and 3).

The introduction of Lundlänken can therefore be viewed as a means to achieve the end of building LRT, since LRT was viewed as having qualities that could realise the urban development potential in Brunnshög, and along the corridor, which a road-based solution could not. Therefore, as Interviewee 4 pointed out, the starting point for the involved civil servants was to enable the construction of LRT, not to strengthen public transport in general.

Expanding the LRT network regionally (both Southwards and Eastwards extensions were discussed at different points in time), but this idea has since been scrapped, and the reasons for that will be explained later on in this chapter.

4.1.2. The urban development perspective

Several of the interviewees in Lund highlighted that what they saw as the superior urban development qualities of LRT in the context of Lund as a central reason for the commitment to this transport technology. According to the interviewees, these urban development qualities consisted of several dimensions.

LRT—quiet, smooth and inflexible

Interviewees 3 and 4 emphasised e.g., the possibility to have grass between the tracks (insert image), and the possibility to reduce local air pollution and noise as factors speaking for the LRT option. Interviewee 3 reflected on that at the time of decision fully electric buses were not a feasible option, so the point of reference was buses with internal combustion engines running on biogas (or other non-fossil fuels). Having grass between the tracks was viewed as positive for urban qualities, since it meant a reduction of hard surfaces for transport infrastructure.

Several of the interviews also emphasised the stability and inflexibility of tracks as a positive aspect from the urban development perspective. Two dimensions of inflexibility were discussed. For the passengers/users, the tracks provide "facts on the ground" facilitating clarity and ease of use; it is easy to understand where the system is and where it is going. The other dimension concerned the long-term perspective in urban development planning, where the stability of the tracks increases the probability that traffic will be conducted along this route for a long time to come, and that this will influence urban structure.

Interviewee 1 also stressed the inflexibility of LRT as a benefit; for this interviewee the main argument was that urban developers expressed a willingness to invest more in the development areas in proximity to LRT stops. Although this understanding of the development companies' view of the merits of LRT compared to road-based systems was only developed at a later stage of the decision process, when the decision to invest in LRT was already made, so it had no actual influence on the choice. For Interviewee 1, it was rather a confirmation that the choice of transport technology was correct.

Related to this, Interviewee 3 said that the idea of a "rail factor" (e.g., that track-based solutions attract more passengers) did play a role in the discussions. Here Interviewee 3 discussed that underlying factors—e.g., more comfortable rides due to less turns and quieter vehicles—could play a role.

LRT as a healing joint in an incoherent urban fabric

Interviewee 4 discussed the legacy of car-based planning in areas traversed by the LRT route as a key planning challenge. Many destinations in the "knowledge path" were planned at a time when the car was the planning norm. An important planning issue was therefore how to "improve urban qualities" along the corridor between the university campus and the science village. This part of the corridor is characterised by lots of parking lots, "urban wasteland", protection zones, and demarcated companies that are anonymous behind the facades of buildings facing away from the corridor. Activities in the area are very much focused indoors, and the area is devoid of public spaces and environments that encourage people to stay outside. Together this meant that this part of the corridor was deemed unattractive as an urban environment and contributed to an incoherent urban fabric. Planners saw the proposed LRT corridor as an opportunity to work on infill development. The infill development would help to turn the backsides of buildings into fronts, and to function as healing joint between previously separated areas along the route, while also stimulating a more vibrant urban atmosphere where people would actually like to spend some time.

Figure 2. Lundaexpressen, the part of the route traversing the campus of the technical faculty of Lund University. Photo credits: the author

According to Interviewee 4, this meant that the LRT was formulated as part of a sustainable attractive urban development in the knowledge path, and a key issue the planners' worked on was how to make public transport part of such development. The central idea is that the LRT corridor will become a city street flanked by new buildings, facing toward the corridor, and with new public spaces encouraging a more vibrant urban atmosphere. In order to achieve such qualities Interviewees 3 and 4 argued that LRT was a better option, since it gave the possibility to plan for buildings and public spaces in close proximity to the actual tracks (which are embedded in grass on this part of the corridor). In contrast, the technology for BRT that existed as a role model in the decision-making process had a great focus on infrastructure, hardened surfaces, and fast-moving, noisy buses, which limited the ideas about urban transformation. Interviewee 4 concluded that these, what he termed "soft arguments", were difficult to communicate to the politicians, in contrast to "hard facts" provided by, e.g., transport economy appraisals.

The contested impacts of LRT on urban qualities

Another perspective on how discussions about urban qualities played a part in the decision process was provided by Interviewee 1. This interviewee argued that the urban quality perspective came in rather late in the process, but was characterised by an emphasis on the negative aspects. Opponents to the project argued that overhead contact lines and poles, and the tracks themselves were negative for the urban qualities of the part of the corridor traversing the historical centre of Lund. The perceived negative impact on the historical parts of the city was, together with increasing concern about the municipality, committing to large investments; key reasons for the opposition to the project forming. The opposition was eventually formalised in the guise of a new political party (FNL), formed in 2014, and since the 2018 elections part of the governing coalition in the municipal government. A representative for FNL is currently chair of the technical committee, which constitutes the political leadership of the local public administration responsible for planning urban infrastructure (including public transport) and urban development. The inclusion of the FNL in the local political government has put an end to the previously mentioned visions of a further expansion of the LRT network (in the city, as well as the ideas of extending the network to the East and to the South). Currently there is a planning moratorium, where civil servants are not allowed to work on matters related to the possible expansion of the LRT network.

4.1.3. Transport function and transport economy

"a city the size of Trelleborg cannot be supplied with a bus line. The solution must have as good bandwidth as possible." (Interviewee 1)

The statement from Interviewee 1 above illustrates that capacity of the public transportation solution was at the core of the discussions leading to the decisions to build the LRT route in Lund. The city mentioned[2] is an allegory for the urban development area, Brunnshög, forming a new part of the Northeastern periphery of Lund. Over the long-term, Brunnshög is expected to house up to 50,000 new inhabitants. This projection

[2] Ironically, in light of the citation from Interviewee 1 above, the local public transport system of Trelleborg is bus-based.

is a considerable a population increase (in light of Lund's current population amounting to 92,000 inhabitants). In addition, two major strategic research facilities—the European Spallation Source (ESS) and MaxLabIV—are also located in the area.

The development plans for Brunnshög have been high profile and characterised by very high ambitions for sustainable development. Part of the ambitions is that the new inhabitants in the area, as well as the work force utilising the new research facilities will use sustainable modes of transport. This ambition is formalised in a politically adopted objective of a 30% modal share for car trips to and from Brunnshög. This means halving the modal share for cars in comparison to other parts of Lund, and constituted a core reason for very high demands on the quality and capacity of the public transport solution. The combination of expansive plans for urban development, and the objective of a 30% modal split for cars resulted in a forecast of a capacity need for 2500 passengers per hour during the maximum hour (Expertgruppen, 2015).

I addition to the urban development aspirations and the 30% car modal share objective, three other concepts were central in the discussions, and described as key reasons for the choice of LRT. The concepts of "practical capacity" and "comfort capacity" are closely interrelated, and also linked to the concept of "reasonable disturbances" for other road users.

This trio of concepts were defined based on the premise that public transport must offer a high level of comfort and that the public transport solution should provide minimised disruption to other transport system users in the city.

The comfort capacity concept for public transport established that passenger comfort will be unacceptably low if more than 30–40% of standing places in vehicles are utilised. The impact this had on the capacity evaluation is shown in Table 2 below. Essentially, this conception of comfort meant that practical capacity, at the vehicle and system level, is virtually halved compared to maximum capacity.

The concept of "reasonable disturbances for other road users", assumed that departure should not be too frequent in order to not impede too much on the right of way for cyclist, pedestrians and motorists. Therefore, a threshold of five-minute frequency of departure was established as a maximum limit.

Table 3. Comfort and maximum capacity of transport modes, Source: (expertgruppen, 2015)

	Comfort capacity (practical capacity)			**Maximum capacity**		
	Per vehicle	Per H (5-minute frequency)	Per H (3-minute frequency)	Per vehicle	Per H (5-minute frequency)	Per H (3-minute frequency)
Normal bus	41	500	800	70	800	1400
Articulated bus (18m)	65	800	1300	115	1400	2300
Double articulated bus (24m)	90	1100	1800	165	2000	3300
LRT(30m)	128	1500	2600	185	2200	3700
LRT (40m)	180	2200	3600			

In combination, the conception of comfort capacity and the five-minute limit on departure frequencies meant that, as is shown in the highlighted column in Table 2, only LRT is capable of meeting the future expected capacity need for 2500 passengers per hour during the time of highest-capacity. Given these premises, a BRT solution could only meet the capacity need with three-minute departures. This way of conceptualising comfort, and imposing limits on departure frequencies, places emphasis on vehicle level capacity, which consequently became an important argument for LRT.

Another aspect related to transport function mentioned by Interviewee 3 was that the high level of right of way for the LRT was closely linked to basic characteristics of LRT as a technical system. Whereas it is theoretically possible to provide the same right of way for a bus as for a tramway car, the "facts on the ground" of LRT makes it easier to avoid compromises. Interviewee 3 emphasised the interplay between technology and politics and argued that in practice, in the municipal decision-making process, the flexibility of bus traffic is a clear disadvantage that typically leads to compromises detrimental to the right of way and priority of buses.

4.1.4. BRT in Helsingborg—genesis and justification

Helsingborgsexpressen is the name of the upgrade of city of Helsingborg's busiest bus line to BRT standard. Helsingborgsexpressen, inaugurated in 2019 is a 11.7 km long bus route, roughly 40% of which is running on separate bus lanes with 21 stops. The service is operated by battery electric buses utilising top-up charging at end stations. In contrast to Lund, Helsingborg used to have a tramway, and the last tramway tracks were removed in 1967. Parts of the route of Helsingborgsexpressen are the same as the historic tramway tracks.

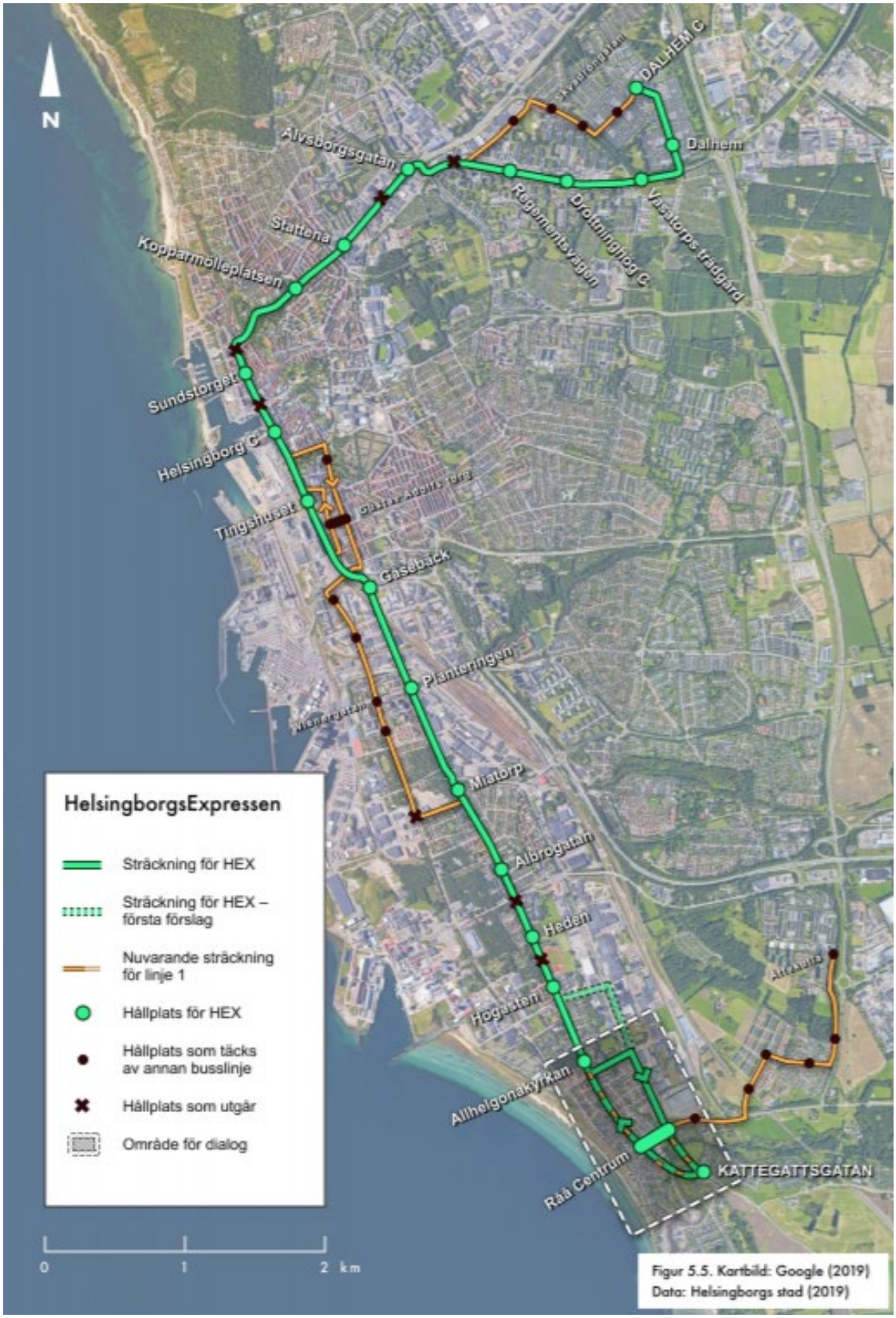

Figure 3. Alignment and stops of HesingborgsExpressen, Source: (Source: Aldgård Wiklund, 2019)

The implementation agreement was signed by the City of Helsingborg, Skånetrafiken (the regional PTA) and the Swedish Transport Administration in February 2016. The agreement stated that Helsingborgsexpressen should be implemented as a tramway-like concept to be introduced on line 1 between the districts of Dalhem and Råå via the city centre. New, upgraded buses were to be used on the line and high priority along the entire route was key to the concept.

In the wider planning context, the 2010 comprehensive plan for Helsingborg stated that the planning of bus traffic in Helsingborg should be based on the principle "think tramway —drive a bus"; i.e., a BRT-inspired type of solution. Important driving forces for this vision was a general increase in patronage on buses in the city, and an ambition to incite a modal shift from car to public transport (Odbacke, 2018). Interviewee 7 said that the ambition was for more people to use public transport in order to improve the environment and to reduce congestion.

In 2013, a decision was made to investigate solutions for upgrading the local public transport system in the city. The directives for the investigation stated that both track- and road-based solutions should be evaluated. Interviewee 7 meant that a road-based solution was considered more realistic by the civil servants working with public transport, not least of which because the concept of BRT was gaining traction in Sweden around this time. During the process leading up to the launching of the investigation, the idea of investing in LRT was brought to the table, largely through the influence of SPIS (the EU-funded project organisation launched with the intention to investigate the conditions for investing in LRT in Malmö, Lund and Helsingborg). The proposed LRT was not only intended as a solution for the city itself, but also performed a regional function by connecting to Höganäs to the Northwest of Helsingborg (Interviewees 5 and 7).

In 2014, the results of this investigation were presented in a report (the city of Helsingborg (2014a). Given the prognosis of patronage on the buses, a solution with 18m articulated buses was advocated. In June 2015, a letter of intent was established between the City of Helsingborg and Skånetrafiken and the planning could be initiated (Odbacke, 2018).

While the decision was to invest in upgrading the standard of the bus lines, an important part of the concept was also the idea that bus lines will have an influence on the development of the urban structure, and over the long-term the intention is to replace bus lines with track-based public transport (City of Helsingborg 2010, p. 37f). The decision to ensure that the BRT system in the future can be transformed to a track-based system influenced certain solutions regarding the design of stops, widths in road sections, and distances between intersections (for LRT to be possible) (Interviewee 7)

The same interviewee also explained that the choice to opt for electric buses was not settled from the start. Instead, it was a result of process of procuring an operator, starting around 2017, where electric buses had become an interesting option. Electric buses where viewed to have several benefits further strengthening the attractiveness of the BRT concept, such as less noise, and no contribution to local air pollution. In general, Interviewee 7 stated that electric buses contribute to a positive image of the BRT system, and of the city.

4.1.5. The urban development perspective

Interviewee 6 described how the geographical context of Helsingborg was an important factor in the choice of public transport system. In a regional perspective Helsingborg is an important functional centre with a concentration of workplaces generating a lot of in-commuting. The city itself has three train stations in the regional train network, which according to Interviewee 6 is the backbone of the public transport system, and the supporting structure in urban planning. The train stations functions as a type of intra-city track-based public transport system, not unlike an LRT system.

A key planning dilemma in Helsingborg is how to facilitate transit-oriented development based on the supporting structure of the three regional railway stations, and how to connect development areas internally in the city. Interviewee 6 also described that the comprehensive planning in the municipality was encumbered with significant uncertainty as to which areas would be developed. These uncertainties played a certain role in the choice of what was considered a more flexible transport solution.

BRT as a means to improve social conditions in peripheral area

Two of the interviewees stressed that Helsingborgsexpressen was closely aligned to urban development issues. Interviewee 6 said that it was a means of achieving desired objectives for urban development at a reasonable cost. Interviewee 7 went as far as to say that Helsingborgsexpressen was structured as an urban development project, with an added dimension of innovations and experimentation since it was deemed uncertain whether a BRT route would deliver the expected urban development effects.

The desired urban development effects were not only about stimulating new development of housing, but a key objective was also to improve conditions in North-eastern suburbs characterised by segregation and social problems. The idea was that improving public transport would have multiple benefits, such as improving accessibility for people already living in the suburbs, and also inciting new development that could have a gradual impact on the socio-economic demographics of the areas, and generally lead to an improved image of the North-eastern suburbs.

According to Interviewee 7, the gamble with choosing BRT to deliver these effects was a success, at least in terms of facilitating new development in the area. Private development companies have generally been positive about the choice of transport technology, or did at least not view this choice as a key factor for deciding whether to invest in the area. According to Interviewee 7, the key has been to show that the public sector is willing to invest in a transport solution that signals faith in the future. This kind of signal value is not dependent on the choice of technology, per se. Interviewee 7 also said that there are examples of new private businesses moving to the city, citing Helsingborgsexpressen as one reason for their choice of location. This interviewee further reflected on the lack of knowledge on what it is that attract with Helsingborgsexpressen, is it improved accessibility, or is it generally an improved image of the city? The interviewee leaned more towards the latter option, but had no substantive evidence on which to base this opinion.

The impacts on more long-term ambitions such as improving social conditions, decreasing segregation, and generally lifting the image of the North-eastern suburbs are—

so far—more elusive. How to measure such effects, and the extent to which these effects are linked to the Helsingborgsexpressen is currently an open question.

4.1.6. Transport function and transport economy

The Interviewees in Helsingborg put forward several important justifications for investing in BRT. First and foremost, the investment cost of LRT was a strong reason for opting for BRT. Both Interviewees 6 and 7 pointed out that the cost–benefit analysis for BRT was "difficult" in the sense that time saving improvements for the buses were off-set by increasing journey times for cars. The right of way in the central parts of the city was a key point of contention. Simulations showed that centrally-located bus lanes would only result in a 15-second time savings per bus, while at the same time this solution would mean that a lot of car traffic would be rerouted and considerable detours would be incurred for the cars (Interviewee 7). According to Interviewee 7, a track-based alternative would have meant even greater negative impacts on car traffic. In addition, it would have also required a complete restructuring of the existing bus network. Finally, a track-based solution would have required the parts of the existing railway network to be moved underground. The covering of the existing railway network was (and is) conditioned on this project entering the long-term national strategic infrastructure planning. Since this project was not included in the national plan, a local, track-based public transport solution was deemed unrealistic, at least in the foreseeable future.

Another result of this evaluation of consequences for buses and cars was that initial proposals for median-aligned busways through the city centre were re-designed to curb-aligned busways (Interviewee 7). This reduces the level of service needed for buses, arguably on the sections of the route where right of way and priority are most needed.

4.2. Discussion and conclusions from case studies

To begin with, the case studies show that that urban development was an important factor in both cases. Here it is notable that the two cases exemplify somewhat different types of urban development. In Lund, the type of development can be characterised as a combination of large scale "green field" development of a new area of the city, plus improving urban qualities in parts of the route characterised by "fragmented urban space". There was a strong interrelationship between the LRT project and urban development plans, with a gestation time of several decades. The arguments about improving urban qualities along the suggested route placed emphasis on choosing a technology with low noise levels, green areas, and not-too-frequent departures. It is interesting to note that the impact of the overhead contact lines and poles, and the tracks were forwarded by opponents to the project as negative for the urban qualities in the part of the corridor traversing the historical centre of Lund—this conception of (conserving) urban qualities became part of the arguments against LRT (and an argument for electric buses).

In Helsingborg, the urban development perspective also played an important role in advocating an upgrade to BRT. Here the perceived flexibility of bus routes was viewed as positive due to uncertainties about future development strategies of the city. Since it

was unclear where to concentrate new development, and how to service future development areas, BRT was viewed as a suitable solution.

Another important urban development aspect in Helsingborg was the expectation that the BRT system should contribute to improving social conditions and the image of peripheral areas in the Northeast part of the city. Here the BRT project intended to play a role in "lifting" areas with social problems. According to the interviewees, the BRT system has so far fulfilled its role and acts as a driver for urban regeneration/development in the peripheral areas of the city it traverses.

Hence, drawing on the findings of the two case studies, moving people from point A to point B was not the sole purpose behind the upgrades. Indeed, we can see that urban development rationales—albeit different types of urban development rationales—have played key roles in both cities in terms of justifying the choice of transport technology.

Turning to transport function, the findings from the two case studies highlight that arguments about capacity and right of way played different roles in the two cities.

In Lund, one interviewee used metaphors such as the LRT system being "the backbone of the transport system" and the importance of adequate "bandwidth" between the greenfield development areas (including the new, massive research facilities) and key transport destinations with primarily regional origins. In addition, in Lund the definitions of "comfort capacity" and the limit on frequency of departures (minimum of five minutes between departures) in order to not infringe too much on the accessibility of other transport system users in the city—acted as key drivers for choosing LRT. Key arguments here were advocating a high-capacity system with "reasonable" vehicle speeds in development areas, and "acceptable" intrusion/consequences for other transport modes in the city.

In Helsingborg, the level of service and especially right of way, were at the centre of a key conflict concerning system design, on the parts of the bus route traversing the city centre. At the core of this conflict were evaluations showing that small travel time gains for buses were offset by large travel time increases for car drivers. This resulted in design choices with curb-aligned busways through the city centre—the result of which is a lower level of right of way, and lower priority for buses compared to the alternative with median-aligned lanes. This illustrates a point made by one of the interviewees in Lund, who argued that the flexibility of buses can result in design choices characterised by compromises. That being said, this argument is based on the rationale that high-capacity public transport is the key objective.

5. Consistency or discrepancy between knowledge claims in research and in planning practice?

The purpose of this study is to compare, contrast, and critically examine knowledge claims in research and in decision making on the choice between track-based or road-based urban public transport systems.

By juxtaposing the results from the analysis of knowledge claims in research with the analysis of the knowledge claims in the case studies, I have identified three discrepancies. Below these discrepancies are discussed as fallacies—fallacies found either in in research or in decision-making practice—that imply risks that the debate about the choice between bus road or track is skewed.

5.1. The urban strategy versus transport tactic fallacy

A key knowledge claim found in research in the ideographic/interpretative tradition (see e.g., Olesen, 2014; Olesen and Lassen, 2016) was to argue for understanding LRT projects as strategic urban development facilitators, rather than as "transport infrastructure projects" (which implicitly or explicitly would be the case for BRT, or road-based services). The results from the two case studies did however illustrate problems with this conception, at least if the claims in research have any generalising ambitions. In both Lund and Helsingborg, it was clear that urban development objectives, and discussions about the impacts of the choice of transport technology on different aspects of urban development played an important role in the debates about which transport technology to choose when upgrading the public transport system.

In Helsingborg there was a clear narrative about upgrading existing bus services to BRT as part of an urban re-development scheme, where improving social conditions in suburbs was seen as important. The interviewees emphasised "non-measurable" aspects, such as image, and signalling that the city has faith in the future development of the areas. This goes against the view of BRT/buses as merely a transport system tactics.

Another result from the case studies, interesting in light of the narrative about LRT as an urban development strategy was found in Lund, where the debates about LRT focused on detrimental effects on urban qualities of tracks and overhead contact lines in the historical city centre. There were also positive aspects concerning LRT and urban quality forwarded from interviewees, but according to several interviewees the public, and political debates on the negative impacts of the LRT on urban qualities became a key issue of contention. This goes to show that the dichotomy between LRT as urban development strategy and BRT as transport system tactics found in some research (e.g., Olesen, 2014) is too

simplistic. Essentially, this raises questions of what is meant by "urban qualities"—and to what extent impacts on such qualities are linked to the choice of transport technology.

5.2. The capacity fallacy

In transport research, especially research advocating the merits of BRT, arguments for measuring capacity at system level, not at vehicle level, are emphasised (e.g., Henscher, 2007). The evidence for this view of capacity is substantial, and the idea that BRT can offer the same, or higher capacity than LRT, at a lower cost has become a key narrative in the academic literature.

The results in this report do, however, indicate that there may be an inherent conflict between the argument that BRT systems can have the same, or higher capacity than track-based modes, while at the same time also offering the potential to play the role of urban (re)development instrument. The conflict lies in that the theoretical capacity of BRT depends on high operational speeds, and frequent departures; i.e., a high level of service and high capacity means driving a lot of buses at high speeds on segregated busways. This can be viewed as problematic from an urban development perspective. This is also in line with the findings of Dai and Cervero (2014) that concluded that too much emphasis on transport function resulted in design choices in the BRT system in Bogotá that stifled ambitions that the system should be an instrument facilitating urban development.

The case study of LRT in Lund illustrated how LRT vehicle capacity is an advantage compared to BRT system capacity (which requires high frequency departure and high operating speed at system level). Here we could see that capacity was an important part of the evaluation of which technology to choose, but the decision process involved different conceptions of capacity compared to what was found in research. "Comfort" and "practical capacity", and the limits imposed on the frequency of departures, resulted in LRT being the only option to meet capacity requirements.

It is of course possible to argue that the conception of capacity in Lund, which was restricted by policy goals such as "comfort" and "practical capacity" and "reasonable disturbances for other transport system users", is wrong according to the constructions used in research. It would, however, be equally fair to argue that concepts of capacity in research should be more sensitive to what is requested in decision making processes, and acknowledge that policy goals; e.g., relating to improving urban qualities, and the comfort of using public transport, could impose restrictions on theoretical capacity when evaluating the choice of transport technology.

The capacity fallacy, illustrated by the different conception of capacity in research versus the case study in Lund is thus that the technical requirements for BRT providing similar capacity as LRT depends on prioritising transport functions above urban development aspects. This is because LRT vehicles can move more people/vehicle compared to buses.

This also highlights a contradiction between frequency of services and improving urban qualities of an area. From a transport research perspective services with high frequencies and high speeds are positive (and bring benefits, such as time savings for the passenger), but from an urban development perspective lower frequency, and more moderate speed,

with the same capacity may be preferred. Additionally, lower frequency of public transport in main transport corridors will have less impact on other traffic flows (e.g., car traffic, but also bicyclists, and pedestrians).

5.3. The flexibility fallacy

The concept of flexibility has a different connotation depending on perspective. From the view of traffic engineering, or a perspective limited to the transport system, the concept of flexibility is a positive trait for road-based systems. This argument has several dimensions. First, the flexibility of buses can allow for handling disturbances and problems on the route; e.g., the possibility to take a detour to avoid being caught in traffic due to for example an accident.

Additionally, one of the interviewees in Helsingborgsexpressen argued that buses were a better option since the long-term urban planning strategy of the city was uncertain. The argument here is that since BRT doesn't need tracks it is easier to readjust the existing route for BRT compared to track-based public transport. However, as Bruun et al. (2017) point out, a key to achieve high quality public transport, regardless of mode, is to make sure there is a high level of right of way. As such, the idea that BRT is a more flexible mode is contradicted by the fact that achieving a high level of right of way is conditioned on making substantial infrastructure investments (e.g., at intersections where it may be necessary to rebuild with grade separation to ensure that public transport vehicles can have top level priority). If such heavy investments have been made a readjustment of a BRT route comes with considerable costs. Indeed, it can be argued that the concept of BRT is about trading the flexibility of buses to ensure a high level of right of way.

In addition, the interviews in Lund illustrated that the inflexibility of LRT had what interviewees perceived as benefits. From an urban planning perspective, the idea of tracks as "facts on the ground" to provide structure for future urban development was one such benefit. In addition, one of the interviewees highlighted that while in theory a BRT system can achieve the same capacities and qualities as a track-based solution, the inflexibility of the tramway was viewed as key reason for not making compromises. Here the inflexibility of track-based modes was forwarded as a benefit in the municipal planning process, where conflicting interests, e.g., concerning how to prioritise between different modes is politically charged. The statement from the interviewee in Lund, that had Lundalänken been a BRT system, it would not have gotten the same level of right of way, is of course impossible to verify. Nonetheless, evidence from other studies (e.g., Pettersson & Sørensen, 2020) indicate that implementing high quality bus priority in cities is indeed difficult. The experience is also corroborated by the findings from Helsingborsexpressen, where the initial design proposal with median busways through the city centre were later, after controversies regarding the negative consequences for car users, altered to curb-aligned busways.

As such, we can conclude that the concept of flexibility, and whether or not this is something positive, depends on which perspective you apply, and it is a fallacy to argue that high capacity road-based systems such as BRT are significantly more flexible than LRT. In order to achieve BRT qualities, especially right of way, flexibility must in turn

be diminished, and public transport corridors require the same infrastructure characteristics regardless of mode. The flexibility fallacy is therefore also linked to a misconception about BRT, where the public debate sometimes seems to focus on the vehicles only. This was the case in Lund, where the opponents to building LRT proposed switching to electric buses as an alternative. This misconception contributes to a risk of overestimating the differences in costs between track-based, and high quality road-based systems. Track-based systems are of course more expensive, but as shown by Hodgson et al., (2013) a BRT service designed with high-specs (i.e., similar right of way and priority as LRT), makes it possible to achieve the same performance levels as LRT with 30% lower capital cost. However, as argued in the preceding chapter, the technical requirements for BRT providing similar capacity as an LRT may require a need to prioritise transport function above urban development aspects.

5.4. What role can research play in choice between BRT/LRT?

The analysis in this report identified some epistemological challenges that can inform future research. Most importantly there is a need for more research, ideally combining ideographic and nomothetic ambitions concerning urban qualities and how these are impacted by the choice of technology.

In most situations, I would argue that regardless of whether choosing BRT or LRT, the ulterior motives are most likely about urban development. The concept of urban development within transport research is however quite poorly understood, and hence there is a need to make clearer what is meant by "urban development". There is a tendency in transport research to bundle multi-faceted concepts, such as "urban development", and "urban qualities" into simplifications—e.g., by using increases in housing prices as a proxy for "urban development" potential, or misconceptions about BRT as merely transport system tactics for "moving people from A to B". Essentially, this boils down to the question of whether LRT as a mode of transport really has intrinsic qualities that makes it superior to BRT from an urban development perspective.

In order to improve the understanding of the roles played by the choice of public transportation technology for achieving different "urban qualities" and urban development objectives, research designs combining transport research perspectives with perspectives from disciplines such as architecture and urban planning merit further investigation.

6. Conclusions

The purpose of this study was to compare, contrast, and critically examine knowledge claims in research, and in decision making on the choice between track-based, or road-based urban public transport systems.

The first research questions posed was: What kind of knowledge claims about the choice of urban public transport technologies (track-based or road-based) are made in research?

The literature review of published papers on the choice of transport technologies identified two general categories of research; positivistic/descriptive studies posing "what is the best choice" type of questions, and hermeneutic/interpretative studies posing "why is a specific technology chosen" type of questions.

Studies focusing on "what is best" type questions tended to find that BRT is the rational choice, based various metrics commonly used in transport economics, engineering, and quantifiable aspects of urban development. Studies posing "why" type questions report that decision-makers highlight LRT as a strategic tool for urban development, in contrast to buses, which are often viewed as merely transport infrastructure projects.

The second question posed was: What kind of knowledge claims about the choice of urban public transport technologies (track-based or road-based) are made in planning practice? Both case studies showed that urban development objectives were key in rationalising the upgrade of existing public transport system in the two cities. In Lund discussions about capacity, and "moving people from point A to point B" were combined with ambitions to improve urban qualities as a justification for choosing LRT. In addition, opponents to the project argued that LRT would have detrimental effects on urban qualities in the historic centre of the city, and therefore advocated a BRT system operating electric buses. In Helsingborg, the interviewees stressed the that the BRT system was an integral part of the urban development plans, specifically with the intention to improve social conditions in suburbs.

The third question posed was: Are the knowledge claims in research and in planning practice consistent, or are there any major discrepancies?

Here three fallacies were identified. First, *the urban strategy versus transport tactic fallacy* questions the dichotomy found in research positioning LRT as a tool for urban development and BRT as transport system tactics, narrowly defined as improving the capacity of public transport systems at a lower cost than track-based alternatives. Second, I argue that there is a *capacity fallacy* found in some research, (typically research promoting BRT as the rational choice) that considers capacity at the system level as the only feasible scope for assessing capacity. The experiences from Lund showed that politically-established objectives for the development of the transport system (concerning comfort and impacts on other transport system users) may impose limits on theoretical system-level capacity assessments. In this case vehicle level capacity enabling high capacity, with less frequent departures, and lower speeds (compared to road-based

alternatives) became an important factor for justifying LRT. Finally, *the flexibility fallacy* addresses the assumption that BRT is a more flexible alternative compared to LRT. This argument is contested on the grounds that if BRT is to perform as well as LRT in terms of capacity, there is a need for major investments in infrastructure, traffic signal systems, stops, and intersections, etc., that radically decreases the flexibility of BRT systems. This discussion also revolved around the issue whether the perceived flexibility of BRT is actually a curse rather than a blessing, based on examples of where said flexibility has resulted in compromises in right of way and level of service.

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