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Vision vs. Evaluation – Case Studies of Light Rail Planning in Denmark

Morten Skou Nicolaisen, Mette Olesen and Kristian Olesen

Abstract

Light rail transit (LRT) is a popular public transport mode used to upgrade the public transport system and support urban development strategies. Despite the seemingly poorer socio-economic return of LRT in cost benefit analyses (CBA) compared to bus rapid transit (BRT) systems, LRT solutions are often chosen over BRT. Several studies show that the decisions to build such systems have not primarily been based on the socio-economic feasibility of the systems. Rather, they are often justified in terms of the branding value and positive image for public transportation, as well as the perceived ability to reduce road congestion and stimulate urban development. Drawing on Actor Network Theory (ANT), the paper analyses how LRT systems have been applied in a Danish context and the role that the CBA has played in this process. The results show that conventional socio-economic factors in CBA, such as travel time savings, play a relatively minor role compared to the larger urban transformation visions that LRT projects are embedded in.

Keywords: *urban planning, transport planning, project appraisal, policy-making, light rail, actor network theory*

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1. Introduction

Modern light rail transit (LRT)[1] has become a popular public transport mode used to upgrade public transport systems and support urban development strategies. Especially so in many middle-sized European cities (Babalik, 2000), where ridership does not necessarily legitimise investments in more expensive infrastructure such as underground metro systems (Mackett & Sutcliffe, 2003). In Denmark, the four largest cities have all made plans for LRT systems; Copenhagen, Aarhus, Odense and Aalborg. From an evaluation perspective, the Danish LRT projects have all displayed poor socio-economic returns, mainly due to travel time delays for car traffic and high construction costs, which are the key components in the Danish model for assessing socio-economic benefits (Landex & Nielsen, 2005). Despite the seemingly poorer socio-economic return of LRT compared to bus rapid transit (BRT)[2] systems, LRT solutions have been chosen over BRT in three of the four largest Danish cities.[3] When decision-makers rationalise these investments, it becomes evident that LRT is not only perceived as a traditional public transportation system. Issues such as city image, quality of urban spaces, and attractiveness of the public transport system constitute all key motivations for implementing LRT projects.

The fact that decisions to build LRT are based on other rationales than those purely related to socio-economic aspects is not only a Danish phenomenon (see Culver, 2017; Higgins & Kanaroglou, 2016; King & Fischer, 2016; Lagendijk & Boertjes, 2012; Olesen, 2014b). However, much contemporary criticism of LRT does not account for this fact (Olesen, 2014a). A recent example is Henscher (2016), who in a comparison of LRT and BRT focuses exclusively on travel time savings to offer a criticism of LRT systems, while ignoring the multifaceted planning priorities in urban transport infrastructure investments that lie beyond considerations included in the narrow framework of cost benefit analysis (CBA) (Næss, 2010). Studies from the United Kingdom show that the decisions to build LRT systems have not been based on the cost effectiveness of the systems here either. Rather, they are justified in terms of the branding value and positive image for public transportation, as well as the perceived ability to reduce road congestion and stimulate urban development (Edwards & Mackett, 1996). Also in many French cities, the choice to build LRT has been based on desires to renew the city, rather than reducing travel time in public transport (Groneck, 2003). Trying to reduce public, professional and academic discourses around LRT to an issue of socio-economic feasibility seems a misguided attempt to oversimplify a highly complex planning issue.

An LRT system can be evaluated on both quantitative and qualitative factors. The quantitative factors are often patronage, travel time savings, construction and operation costs etc. (Nicolaisen & Driscoll, 2014). The qualitative factors are more difficult to determine and operationalise, since they hold a much larger complexity. The qualitative factors are often described as the comfort offered by the system, reliability and visibility, user preferences, and transformations of public spaces in the corridor,

as well as strategic urban development potentials (Olesen, 2014a). In practice, decision-makers and planners often include qualitative factors in decision-making processes, by highlighting LRT projects' role in supporting broader political visions, as counter arguments to the projects' relatively poor (quantitative) socio-economic evaluation compared with BRT alternatives.

This paper explores the gap between policy and planning rationalities for implementing LRT projects and the rationalities, which are underpinning transport modelling and socio-economic evaluations in Denmark. Drawing on Actor Network Theory (ANT), the paper analyses how LRT systems have been applied in a Danish context, by examining how actors have been enrolled into a larger LRT network, and how, as part of these processes, the perception of LRT projects has changed from transport infrastructure projects, focusing on travel time, to urban development projects, supporting strategic spatial visions.

In conclusion, the paper discusses the need for closing the gap between the perceived strategic benefits of LRT systems and the benefits included in the decision support, in order to develop more democratic and transparent decision-making processes. Furthermore, the gaps between political visions and rationalities for implementing LRT, and the results of socio-economic evaluations raise important questions of on which ground political decisions to implement LRT systems (or not) are taken, and if the existing decision support tools are sufficient for handling the complexities that are inherent in many larger infrastructure projects.

2. The role of cost benefit analysis in decision-making processes for LRT projects

Since Dupuit introduced the early concept of what is now known as CBA in the mid-19th century, the utilitarian approach to appraisal of public works has gained widespread popularity, and is now a stable element in the repertoire of most modern planning authorities. This is especially the case in transport infrastructure projects, where CBA is by far the most dominant appraisal form in many countries around the world, including Denmark (Hayashi & Morisugi, 2000). A key aspect in this appraisal method is the reliance on accurate forecasts for a range of impact categories, of which the most important are typically construction costs (the main expense item) and travel time savings (the biggest benefit category) (Banister, 2008; Nicolaisen, 2012).

There are several recognised flaws in the application of CBA for transport infrastructure projects (Ackerman & Heinzerling, 2002; Næss, 2006; Salling & Banister, 2009; van Wee, 2011). Of particular interest in the present paper is the high focus on solving traffic bottlenecks compared to supporting visions for spatial economic developments (van Wee et al., 2006). This can lead to tensions in planning processes, when CBA is used to assess LRT systems that are not valued solely for their ability to increase network flow (Beukers, Bertolini & Te Brömmelstroet, 2012). In such cases, project proponents often feel that the appraisals

fail to appreciate the true value of the project, if the important benefits cannot be quantified into 'hard facts', such as travel time savings. This has led to a push in transport research to develop more holistic modelling approaches, which are able to reflect the many interactive feedback loops between land-use planning and transport systems (Banister, 2008; Cervero, 2009, van Wee & Roeser, 2013).

Furthermore, some researchers argue that CBA results often have limited influence on the decisions made by policy-makers (Eliasson & Lundberg, 2012; Sager & Ravlum, 2005). Others claim that CBAs are often manipulated or used selectively to legitimise projects that have already been decided politically (Wachs, 1989; March, 1994; Flyvbjerg, 2007). Others argue for a need to rethink modelling tools with an increasing focus on pedagogy and the ability to explore a variety of options (Klosterman, 2012; Nicolaisen, 2012).

In the last couple of decades, many medium-sized and small cities in Western Europe have implemented LRT systems, despite the fact that these are often more expensive solutions and display poorer socio-economic returns than comparable BRT systems (Deng & Nelson, 2011; Hodgson et al., 2013). When justifying these investments, cities often outline the flexibility of LRT systems in terms of meeting a diverse set of goals, including the provision of viable, affordable and attractive alternatives to the automobile, whilst contributing to more liveable and sustainable cities (Bottoms, 2003). De Bruijn and Veeneman (2009) highlight two issues in their critique of LRT decision-making processes. First, De Bruijn and Veeneman argue that LRT systems should not only be assessed as a transport technology, but must be considered in a broader context of revitalisation of the city centre, developing new office estates, greening transportation, and refurbishing existing roads. Second, De Bruijn and Veeneman's study concludes that BRT systems lack the mythical 'allure' often linked to LRT systems, which can help mobilise various actors in the support of the project. Several researchers highlight that the choice between LRT and BRT is not only based on technology, but also on the type of service, image, and urban development impacts (Henscher, 2006; Vuchic, 2000). The choice of whether and how to realise LRT systems can be seen as a multi-actor decision-making process: to make the right decision requires the involvement of a wide range of experts and stakeholders, who might have perspectives and values beyond the economic rationale provided in the CBA (De Bruijn & Veeneman, 2009).

In addition, there is considerable debate about the effects of LRT systems. In a study of the performance of LRT systems, Babalik-Sutcliffe (2002) concludes that none of the systems meet the objectives of reducing car traffic, air pollution, and increase in modal share for public transport. In another study, Bhattacharjee and Goetz (2012) find that the implementation of three LRT corridors in Denver has an effect on lowering the traffic increase on highways. In a recent literature review, Knowles and Ferbrache (2016) argue that LRT systems can have a range of wider economic effects on cities, such as unlocking new sites for (re) development, eliminating transport constraints, extending labour market catchment areas, and increasing land and property values.

The brief literature review illustrates that there are continuous debates on CBA's role in decision-making processes for infrastructure projects, not at least when it comes to evaluation of LRT systems, where multiple factors and actors are involved. The aim of this paper is to examine this dilemma through an analysis of CBA's role in decision-making processes for LRT projects in Denmark. The analysis illustrates how the downfalls of CBA have been actively exploited to emphasise and articulate that strategic qualitative values are not captured in the results of CBAs. In the next section, we set out our analytical framework for this analysis.

3. Analytical framework: LRT as a travelling idea

The analytical approach adopted in this paper is inspired by the socio-technical movement within mobilities studies, which, among other perspectives, is inspired by the relational thinking applied in Actor–Network Theory (ANT) (Latour, 2005; Jensen, Lauritsen, & Olesen, 2007). The mobilities perspective emphasises that light rail projects must be understood as more than the movement of people from A to B. Light rail projects are made up of a constellation of strategic urban development policies, urban transformations, operating policies, technologies etc. Deconstructing these constellations of light rail mobilities are important for understanding how light rail mobilities are produced, reproduced and performed. The ANT approach enables an understanding of the role that light rail technology plays in the construction of urban politics and spatial and mobility practices. Through the process of deconstruction, the human and non-human entities that make up light rail mobilities can be identified, along with their role in the relational constellation. On the contrary to purely discursive and policy-based analyses, an ANT approach draws into attention the roles that the materialities of light rail have in interactions with the city, and how dominant discourses of decision-making processes materialise in the city and produce local configurations of light rail mobilities.

Light rail projects constitute an interesting object of study, as they are performed by rational decision-making tools and models such as CBA, but also by strong normative aspirations, spatial visions and diagrammatic representations of the aesthetic and spatial values of the projects (see also Olesen 2014a). By adopting the ANT approach, we draw attention to the importance of both human and non-human actors within the network. This means that the same analytical and descriptive framework is applied when faced with a human, a text or a machine. Drawing on Latour's semiotics of an actor as an actant, we define an actant as "something that acts or to which activity is granted by another [...] an actant can literally be anything provided it is granted to be the source of action" (Latour, 1996, p.373). In this paper, we are interested in how light rail technology (tracks, vehicles etc.) in its relations, is granted with another source of action than for example a BRT system.

In this paper, we furthermore conceptualise LRT as a 'travelling idea' (Tait & Jensen, 2007, see also Olesen, 2014b), which - besides being a technology - is also associated with certain values and rationalities, e.g. sustainable mobility, transit-oriented urban development, liveability and economic growth. In order to develop an understanding of how and why policy-makers decide to implement LRT systems in Denmark, despite their poor socio-economic return of the investments, we draw on concepts from ANT to analyse how the LRT idea has been applied in local settings, and which actants have been important for moving these processes along (Callon & Law, 1982; Callon, 1986; Tait & Jensen, 2007).

Drawing on Callon's (1986) sociology of translation, we conceptualise the process of applying LRT systems in a Danish context as made up of four stages of translation: problematisation, interessement, enrolment, and mobilisation of allies. The first stage, 'problematisation', refers to the initial process of making the idea (LRT) relevant in a Danish context by matching it with 'local problems'. The second stage, 'interessement', relates to the moment in the process where the identities and interests of the actors in the process become stabile and clearer, including which additional actors must be 'enrolled' into the network. The third stage, 'enrolment', includes then the process of enrolling important actors into the network. Callon and Law (1982) have described how actors try to enlist one another in a variety of different ways by the use of different strategies, including the transformation of imputed interests. The fourth and final stage, 'mobilisation', refers to the stage in the process when actors start to speak for others or on behalf of the network, establishing themselves as spokespersons (Callon, 1986; Tait & Jensen, 2007).

In the decision-making processes of implementing LRT systems in Denmark, we are particularly interested in the stage(s), in which the processes change from being mostly concerned with infrastructure and travel time savings, to also incorporate urban qualities and strategic urban development as important parameters. Mol (2002) has argued that different practices take an active role in producing reality, and that practices tend not only to produce different perspectives, but also different realities. This is what Mol (2002) identifies as the problem of multiplicity. In the case of LRT, this implies that practices produce different realities of LRT systems, e.g. ascribing different values to the technology. However, this also implies that actants will have political reasons for preferring and enacting one kind of reality rather than another (Law, 2004).

Drawing on Callon and Law (1982), the process of translation can be understood as the process of enacting certain realities of LRT politically. In decision-making processes, alliances of actors articulate various interests and courses of action to pursue according to their interests and claims about how the world works. This process is linked to different narrative and material constructs of a given problem. In order to translate one view of reality to another, different tactics or persuasive actions are needed, in order to enrol actors and convince them that certain viewpoints of the world are interesting and relevant for the sub-

ject discussed. In the process of enrolment, tools or 'inscription devices' (Latour & Woolgar, 1986) are often used to supplement discursive argumentation in the process. An inscription device refers to the graphical and figurative activities that are part of the scientific production of facts and theories (Olesen & Kroustrup, 2007, p. 69). CBAs can along with maps, reports and other non-human actants be understood as inscription devices, which support decision-making, whilst at the same time representing certain values. These inscriptions can be used to translate the interests (and values) to a specific audience.

In our analysis, we are interested in the role that actants (human and non-human) play in facilitating this translation process. Law (2009) stresses that we must not only attend to language in the study of socio-technical construction processes. The material plays also a role in these processes. Entities achieve their form as a consequence of their relations – meaning that they are performed in, by and through these relations (Law, 2009). This means that in an analytical sense, human and non-human actors are considered in symmetry, and should be understood and analysed according to the role they play in the network (Fuglsang, 2004; Latour, 2005). In the case of LRT projects, actants can be politicians, planners, reports, legislation, cost benefit analyses, and technologies (LRT/BRT), which all play a role in shaping the arguments used in the decision-making processes.

Attention should also be paid to how discourses and narratives are constructed to enrol actors in the process. Here, we draw on Hajer's (2006, p.67) understanding of discourses as "an ensemble of ideas, concepts, and categories", which are used to give meaning to the social and physical world, and which are produced and reproduced through particular practices. Here, the use of language (and signs and symbols) plays an important role in the construction of particular realities, which actors might buy into. To give an example, it makes a difference whether LRT is discussed and understood as a transport infrastructure project or an urban development project, as the different framings of LRT will lead to completely different constructions of 'reality'.

In our analysis of how LRT has been applied in a Danish context, we explore i) the multiple realities represented in the LRT projects, ii) the different discourses, inscriptions and actants, which contribute to the construction of these realities, and iii) the stages in which translation takes place, transforming the values and interests in the processes and thereby enacting one reality over another.

4. Methodological approach

The research of the decision-making processes for implementing LRT systems in the three biggest Danish cities Aarhus, Odense and Copenhagen (Ring 3) has been carried out in a few basic steps. First, key actants and key events are mapped, focusing on actants at different scales (national, local and global) in the decision-making processes, as well actants representing different practices (the bureaucrats, the planners, the consultants and the politicians), see table 1. Insights from these actants

have enabled us to frame different realities present in the processes and the most important discourses linked to these realities. The authors are aware of that other actants, than the ones included in the present study, have played a role in the decision-making processes, such as interest organisations and lobby organisations for or against LRT. However, the point of departure for this research has been to map actants, who have been directly involved in the decision-making processes between the state and the local projects.

Second, semi-structured qualitative interviews have been carried out with key human actants, in order to get central viewpoints on the decision-making processes (see table 1 for actors interviewed). Interview questions have been grouped around central questions, such as the local perspectives on the reasons for implementing an LRT system, the discussion of LRT vs. BRT in this decision, the role of the CBA (and other issues of financing), and the role of other decision support tools in the process (strategic visions, maps, reports etc.). Furthermore, the interviews are used to generate information about the processes of enrolment, such as which actions led to what (Hajer, 2006), and which actors have been enrolled and by the use of which argumentation and discourses. In addition, the role of various non-human actants, such as tools and inscriptions have been identified in the processes of enrolment.

Table 1: *Mapping of the actants in the decision-making processes – the mapping of these key actants and their relations form the empirical basis for the analysis.*

	Actant	**Strategic role**	**Persons interviewed**
	THE NATIONAL LEVEL		
Human actants	The Danish National Parliament	The political committee of transport – decides on infrastructure projects and is the obligatory passage point for funding to local infrastructure projects.	Political spokesman for transport policy from the Social Democrats. The Social Democrats were the leading party in the parliament in the period 2011-2015.
Human actants	The Danish Ministry of Transport	National funding for transport projects and provider of the TERESA model	Economist in the Ministry of Transport working with the TERESA model on the national level
Non-human actants	The Danish appraisal model TERESA	Systematic method for evaluating and comparing benefits and cost of transport projects. The results produced are inscriptions of many complex assumptions.	
Non-human actants	National strategies on public transport	The political goals for public transport in a strategic perspective	
	THE LOCAL LEVEL		
Human actants	Project secretariat: Aarhus, Odense, Ring 3 Copenhagen	Project planning and implementation – Spokespersons for the local political framings of the LRT projects.	Project manager, Aarhus LRT Project manager, Odense LRT Project manager, Ring 3 LRT
Human actants	Consultants	Consulting planning processes for LRT projects, performing socio-economic analyses.	Engineer and consultant from COWI – consultant on the Danish LRT projects
Non- human actants	Spatial urban visions	LRT is inscribed into local spatial visions for urban development. These documents are used as the basis for decisions and are part of enrolling local partners into a shared vision.	
Non- human actants	Preliminary analysis reports: Aarhus, Odense, Ring 3	Inscriptions of the visions behind the projects – and initial comparison of LRT and BRT – and initial CBA screenings.	
Non- human actants	Evaluation reports: Aarhus, Odense, Ring 3	Evaluations of the projects. Inscriptions of benefits and values of the projects, quantitative and qualitative. Argumentation for the quantitative and qualitative values in the project.	
	THE GLOBAL LEVEL		
	Experience from other LRT cities.	Examples of the strategic urban values from LRT in other contexts. Visualisation of the LRT visions in 'reality'.	

5. Translating LRT systems into a Danish context

The idea of implementing LRT in a Danish context has been discussed politically since the end of the 1990s and the beginning of the 2000s (Melchior, 2008). The Danish Government has supported the implementation of LRT in three political agreements: Agreements on a Green Transport Policy (Danish Ministry of Transport, 2009), Agreements on Better and Cheaper Public Transport (Danish Ministry of Transport, 2012), and Light Rail in the Capital, Busses and Bicycles (Danish Ministry of Transport, 2013) – the latter securing funding for the LRT in the Greater Copenhagen Area. All agreements have been obligatory passage points, guarantying state financial support for LRT systems in Denmark (Interviews Aarhus LRT; Odense LRT; Ring 3 LRT).

The decisions to implement LRT systems have been supported by strong local political visions of upgrading the public transport systems, and use LRT as strategic tool for urban development in the three largest cities Copenhagen, Aarhus and Odense. In Copenhagen and Odense, socio-economic analyses have been prepared comparing LRT and BRT (Danish Ministry of Transport, 2010; Odense Municipality, 2011a). In Aarhus, a bus solution has been implemented as a first step paving the ground for the later implementation of LRT. Despite the fact that the socio-economic analyses have proved that LRT will be the costlier solution (see table 2), all cities have opted for the LRT solution, prioritising its qualities as a strategic tool for urban development. Table 2 summarises the main characteristics of the three LRT systems. In the following sections, we trace how LRT has been applied in each local context.

Table 2: *Overview of the Danish LRT projects. Sources: Danish Ministry of Transport, 2010; Odense Municipality, 2011a). * New estimated opening year.*

City/ Year/ Inhabitants	Length, stops, travel time	Estimated Costs billion DKK State financial support	Mio. DKK/km	Present value (NNV) (mio. DKK) Internal rate	Estimated no. passengers/day
Aarhus / 2017 / 250,000	12 km/18 stops	LRT: 1.1 DKK State: 0.6 DKK	94	NEG	?
Greater Copenhagen Area / 2023* / 1,800,000	27 km/28 stops	LRT: 3.7 DKK State: 1.7 DKK BRT: 2.4 DKK	132 86	NVV: -2,581 Rate:+2,8 % NVV:+528 Rate: +5,7 %	57.820 passengers/ day (2018) 53.400 passengers/ day (2018)
Odense / 2020 / 170,000	14 km/26 stops	LRT: 1.6/2.3 DKK State: 1.1 DKK BRT: 1.3 DKK	109 88	NVV: -4.157 Rate: neg. NVV: -4.296 Rate: neg.	25.100 passengers/ day (2020) 20.400 passengers/ day (2020)

5.1 Aarhus – LRT and the European capital of culture

Denmark's first LRT system is expected to open in Aarhus in 2017, supporting Aarhus' nomination as European cultural capital of the year 2017 (Letbanen, 2013). In this way, the LRT plays an important strategic part in the branding of Aarhus as culture capital - forming a 'cultural

capital and LRT city' network in Aarhus. Aarhus has, as the second largest city in Denmark, a large catchment area of workplaces and the current commuter flows add considerably pressures on the existing urban infrastructures. Part of the rationale for implementing the LRT system has been to promote alternative transport modes in order to solve ongoing traffic problems. The 'problematisation' around the issue of congestion led to the formation of a network consisting of Aarhus and the surrounding municipalities, with the aim of constructing an urban network, inspired by the Finger Plan for the Greater Copenhagen Area (Egnsplankontoret, 1947), linking Aarhus to the main towns in the surrounding municipalities by public transportation. A map illustrating this spatial vision has acted as an inscription of the urban development vision behind the project, and contributed to the enrolment of political partners in support of the project (see figure 1). Furthermore, the LRT has been inscribed into the spatial vision as a physical manifestation of the metaphorical 'fingers', supporting transit-oriented urban development. The strategy has been to integrate the new LRT system with some of the existing 'fingers' in the network, the regional railway lines to Grenaa and Odder. As the first fingers in the network have been rail based solutions, a dedicated rail infrastructure network has been the logical continuation of the network. Figure 2 illustrates the LRT network in Aarhus.

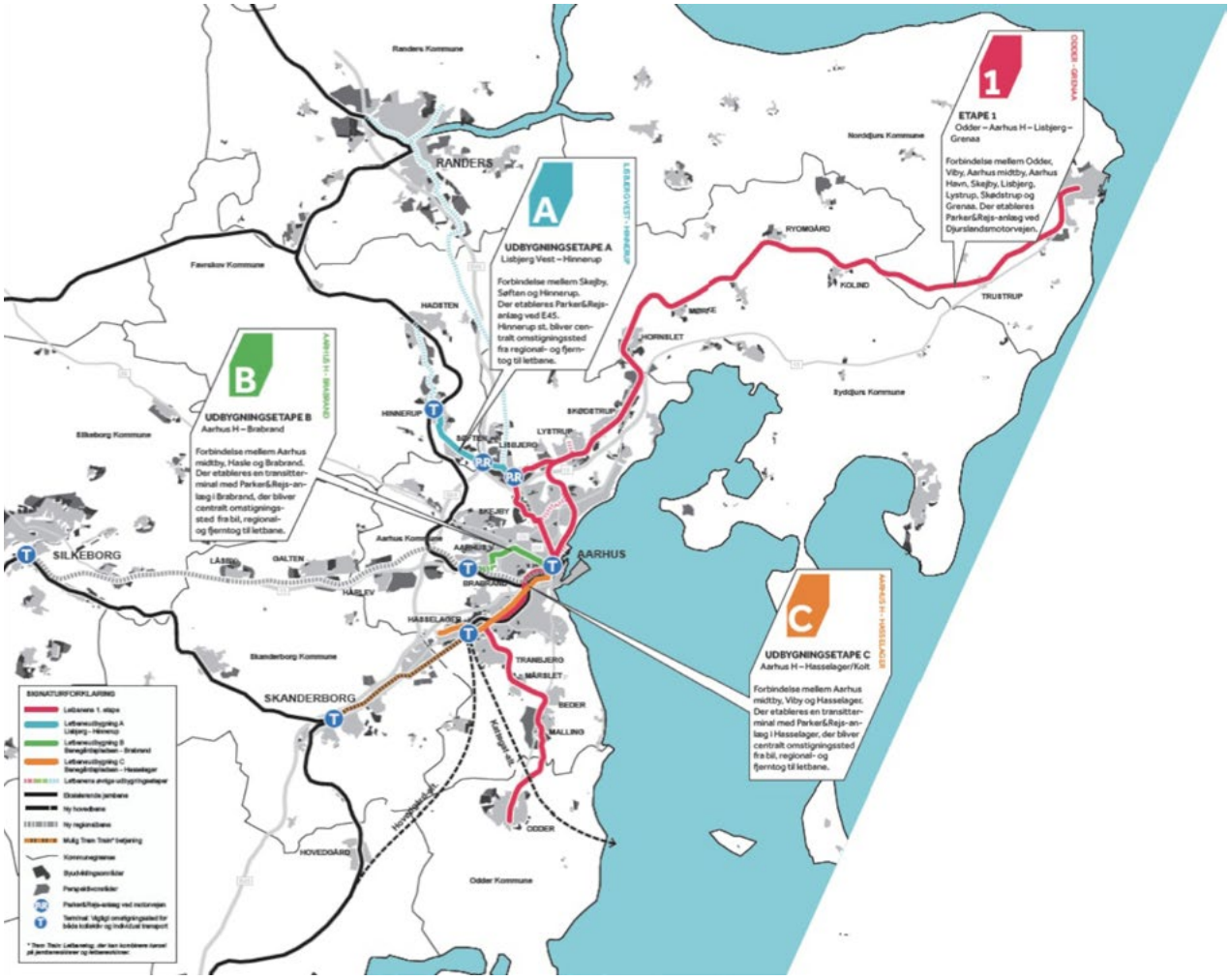


Figure 1: *Spatial vision for Eastern Jutland – 'the Aarhus Finger Plan'. Source: Midttrafik Letbanesamarbejdet & Letbanen, 2013, pp.2-3.*

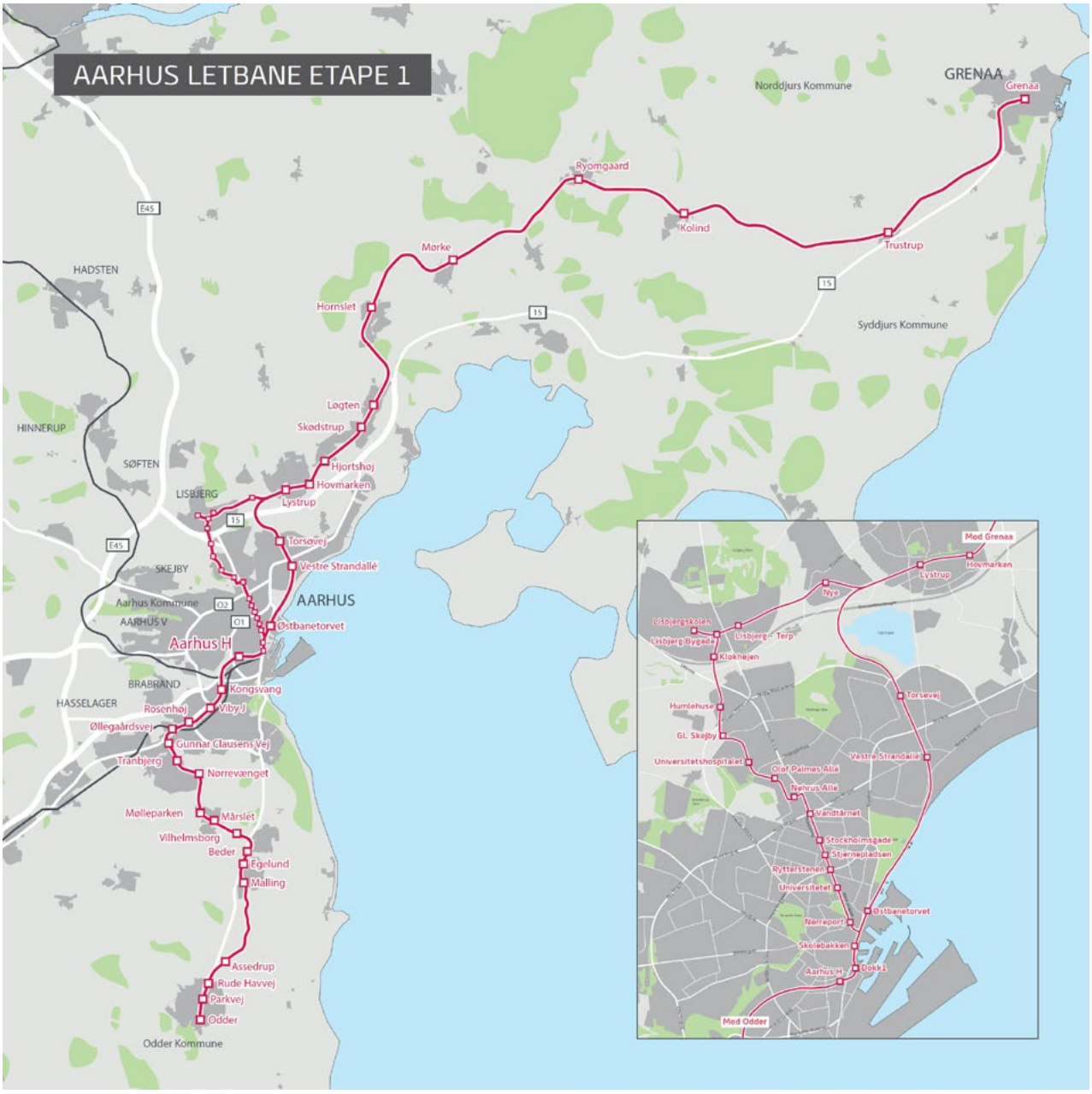


Figure 2: *The LRT network in Aarhus (stage 1). Source: Letbanen.*

As a first step in the implementation of the LRT system, bus lines have been implemented to pave the way for the LRT under the slogan 'think tram, drive bus' (Interview Aarhus LRT). When implemented, the LRT will serve an important strategic area in the northern part of Aarhus housing the university hospital, the university, and several large workplace-clusters. In addition, Lisbjerg, a small town of 900 inhabitants, has been designated as a strategic urban development area in this northern corridor. This area has been planned according to new denser urban development principles, allowing the area to accommodate 10,000-20,000 citizens in the future (Aarhus Municipality, 2009). Furthermore, Aarhus harbour is undergoing a major urban transformation process from industry to housing, office spaces etc. The LRT has been planned to run along the harbour front, and a narrative has been constructing underlining the LRT as an important actant for creating new connections in the city, breaking down the current mental and physical barriers between the city and the harbour (Letbanesekretariatet Midttrafik, 2013).

The vision of implementing LRT in Aarhus dates back to the beginning of the 2000s, however, the project was not supported by the state until it was decided to implement metro/LRT in Copenhagen. Instead, dedicated bus infrastructure has been implemented as a preparation for a LRT solution. In 2009 the state announced that it would support the LRT project financially - one year before the CBA results were published in 2010. This suggests that the spatial vision of linking the Greater Aarhus Area together has been the stronger actant in the mobilisation of state support for the project. In 2011 a political agreement was signed guarantying that the state would pay 0.6 billion DKK of the construction costs (Danish Ministry of Transport, 2011b).

5.2 Odense – developing a big city image

In Odense the LRT is a part of the vision of transforming the city's image from being a larger Danish city into a 'big city' (Odense Municipality, 2011b). The vision is to connect the suburbs and new important urban development projects to the south east of the city, such as the expansions of the university hospital and the university, to the city centre and the railway station via a LRT link (see figure 3). The implementation of the LRT has been 'problematised' with a point of departure in its strategic role in facilitating an urban transformation process around the major road in the city centre, Thomas B. Thriges Gade (Odense Municipality, 2011b). The road was constructed in the 1960s to modernise Odense and accommodate the increasing volumes of car traffic. The goal of the

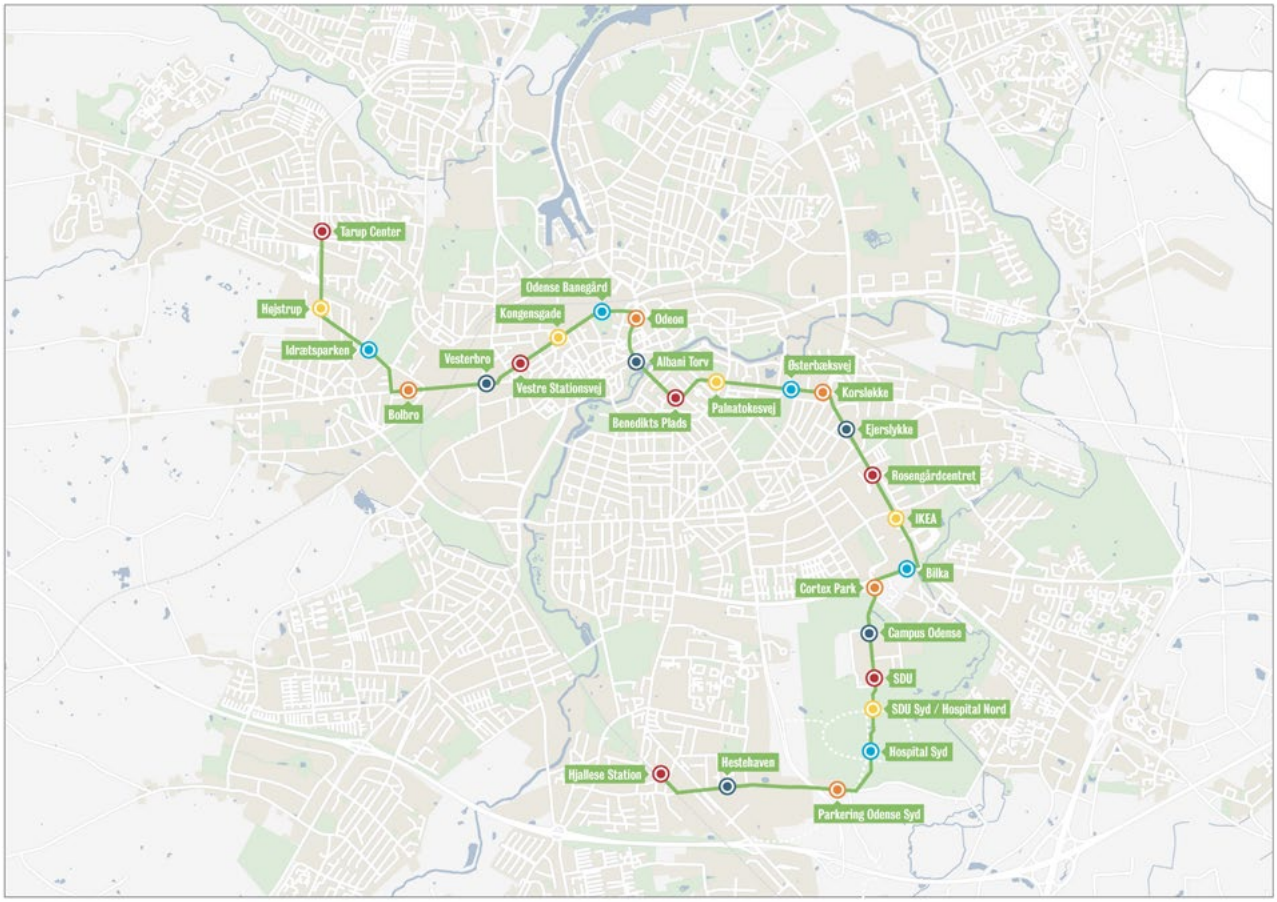


Figure 3: *The LRT network in Odense. Source: Odense Letbane.*

transformation process has been to develop and connect separated urban areas and change the mobility hierarchy in the city, reducing the role of the car under the vision 'from street to city'. These visions have been inscribed in the traffic and mobility plan from 2009 (Odense Municipality, 2009). As it is often the case for objectives restricting car use, the plan has been modified due to pressures from powerful citizen groups, who managed to create 'interessement' against the plan and mobilise actors against the restrictions for car use in the city. As a result, a new traffic plan has been implemented, allowing more car traffic in Odense than originally intended (Odense Municipality, 2013a). A part of the 'interessement' and 'enrolment' for the LRT project has been carried out by an architectural company, who has played an important role in illustrating the urban qualities associated with the LRT solution. These illustrations (and narratives) have become important inscriptions in the 'enrolment' of actors in support of the project (Juul & Frost Architects, 2010).

In Odense, the LRT vision has been integrated into all the spatial urban development plans for the city, and in this sense, it has been an important actant in the overall spatial vision. This also explains why the local politicians advocated the LRT solution, despite the fact that the BRT proved to be the better alternative in socio-economic terms. In 2014 a political agreement was signed guarantying that the state would pay 1.5 billion DKK of the construction costs, now estimated to 2.3 billion DKK (Danish Ministry of Transport, 2014).

5.3 Ring 3, Copenhagen and the Loop City

In the Greater Copenhagen Area, the vision is to implement an LRT system along the outer ring road, Ring 3, connecting 11 suburban municipalities (see figure 4). The LRT has been a powerful actant in enrolling the 11 municipalities in an agreement on a political vision of transit-oriented urban development in the corridor (Loop City, 2017). The need for LRT has been 'problematised' by the great transport demand from commuters travelling between and across the existing regional S-train lines, dating back to the 1947 Finger Plan (Interview Ring 3 LRT). The LRT has been 'problematised' as a means to upgrade the rail-based public transport network in the Greater Copenhagen Area in line with contemporary commuter needs. Whilst the LRT has been highlighted as a strategic actant for solving transport issues, it has also been promoted as an important actant for facilitating urban development along the Ring 3 corridor. In addition, the LRT has been 'problematised' as a part of the vision of the Loop City, a rebranding of the Danish-Swedish cross-border Øresund Region proposed by Bjarke Ingels Group (BIG) in 2010 (BIG, 2010, see also Olesen, 2017). The vision has played an important role in mobilising political support for the LRT project, and in rationalising the LRT as an investment in suburban redevelopment, rather than a matter of choosing the most cost-effective mode of transport (Interview Ring 3 LRT). Along the Ring 3 corridor, there are many former industrial areas suitable for redevelopment, and the LRT has been articulated as the driver and backbone for this redevelopment process (Olesen, 2017).

Figure 4: *The LRT network in Ring 3 in the Greater Copenhagen Area. Source: Loop City.*

In the Ring 3, the spatial vision of the Loop City was announced simultaneous with the CBA analysis and the technical report (Danish Ministry of Transport, 2010). This illustrates the important role of the vision in guiding political decision-making on the LRT project. The project manager summarises the importance of the spatial vision as follows:

> I have no doubt that it [the Loop city vision] was important, not as a thoroughly calculated project, but as a spatial vision (...) The fact that this report came at the same time as the report 'LRT or BRT in Ring 3' contributed to creating a clear picture of the vision, and which system supported this vision within the frame of the project. (Interview Ring 3 LRT)

In 2011 and 2013 political agreements were signed guarantying that the state would pay a total of 1.7 billion DKK of the construction costs (Danish Ministry of Transport, 2011a, 2013).

5.4 The enrolment of actants – an overview

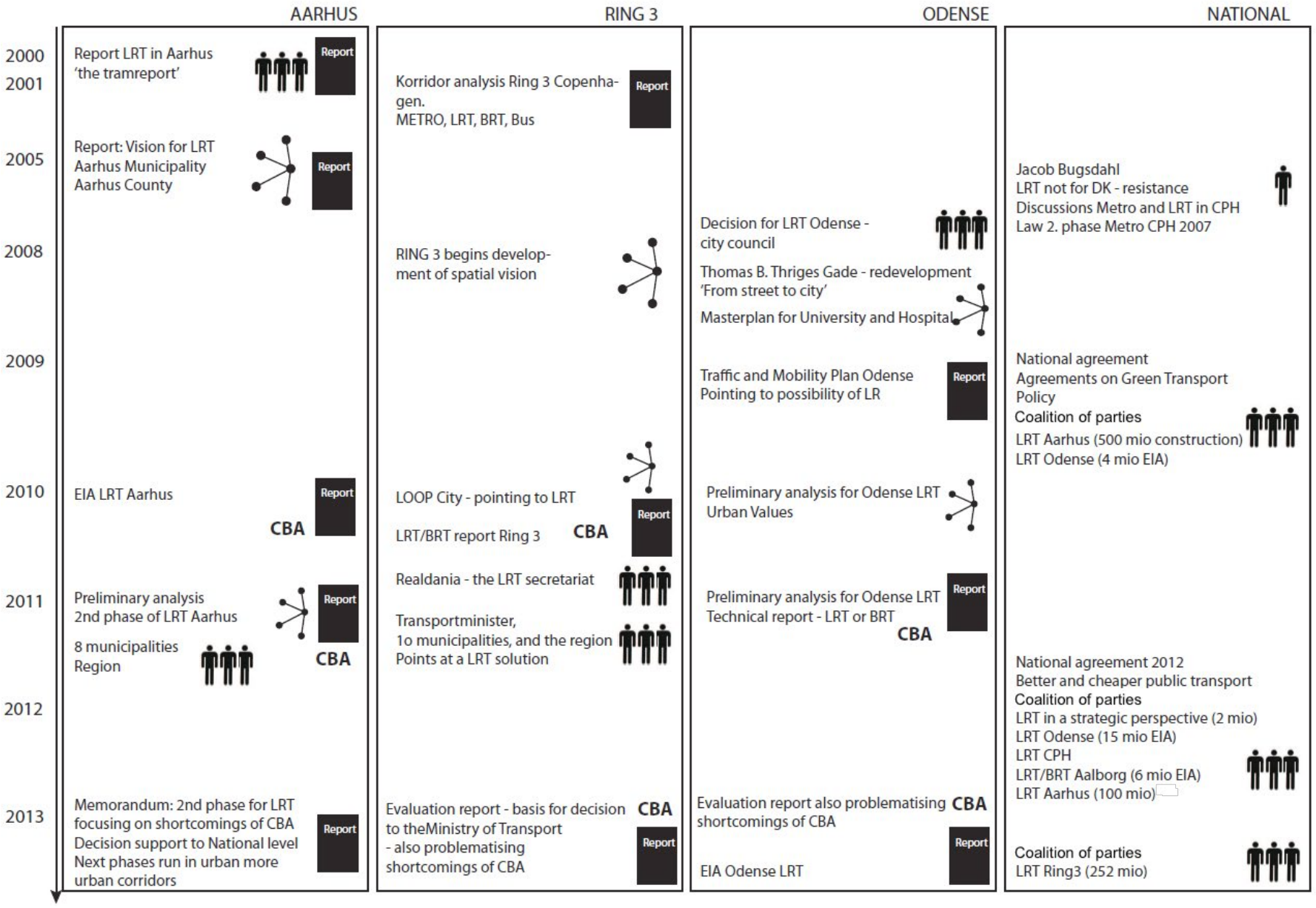
The analysis of the three decision-making processes illustrates how LRT technology has been an important actant in promoting certain planning ideals and inscribing these into political visions of transit-oriented urban development. All Danish LRT projects have been inscribed into local and regional visions of urban development and branding, underlining the rationale of the projects as more than transportation. The benefits associated with implementation of LRT systems are perceived to have a wider contribution to society than what is often assumed in cost benefit analyses. Table 3 summarises the main actants in the three decision-making processes for implementing LRT.

Figure 5 summarises the processes of translating LRT systems into a Danish context, with a particular focus on when and through which means actors have been enrolled in support of LRT systems. Furthermore, the figure illustrates how the values (and realities) associated with LRT change over time, as the LRT projects are reframed from transport infrastructure projects to urban development projects. This shift in focus towards including strategic urban development perspectives has been crucial in order to outweigh the poor evaluation of LRT in the socio-economic analyses. This suggests that there is a value gap between the policies and planning rationales behind decisions to implement LRT in Denmark, and what the CBAs estimate are the projects' socio-economic contributions to society. We turn our attention towards this issue in the next section.

Table 3: *Presentation of the main actants and their role in the three LRT decision-making processes. The table builds on document analysis as well as interviews (see table 1).*

Actants and their role	
LRT	• Driver for spatial urban development visions • Attracts business investments • Has higher potential for capturing car modal share than BRT
BRT	• Cost-effective solution for provision of fast public transportation • Lack of permanency limits the station-proximity effect • Limited ability to provide the desired comfort levels
Ministry	• Needs effective ways to distribute limited funds for infrastructure development • Is focused on the robustness and reliability of the appraisal methodology • Considers itself aware of the additional impacts that CBA does not cover • Is considered to focus too much on CBA compared to the non-transport related local objectives
Consultants	• Act as mediators between the Ministry of Transport and the local parties • Try to highlight the excluded effects that local parties prioritise
Parliament	• Decision-makers who take the CBA into account along with other input • Is considered aware of the limitations in the appraisal framework
Traffic models	• A major barrier in project approval due to resources required • Vital to the CBA appraisal framework
TERESA	• Comprehensive economic evaluation framework for transport effects • Limited flexibility in regards to land use and other non-transport effects • Is almost exclusively focused on travel time savings and ridership demands
Evaluation reports	• Important items of communication in the perspective of the local parties • Acts as a focal point for the interests of the local parties
Aarhus	• Primary objective is to resolve the mounting congestion issues by modal shift away from cars • The public transport vision is seen as an anchoring point for the future urban development (Lisbjerg etc.) • Many local parties but with Aarhus Municipality as the dominant • Bus priority and dedicated lanes are supposed to ease the transition to LRT • Anchored around the Finger Plan for Eastern Jutland
Odense	• Removal of car traffic (Thomas B. Thriges Gade) is a main policy objective Vision “from street to city” • The public transport vision is seen as an anchoring point for the future urban development (Uni. Hospital, university, Science Park etc.) • Penalty for car drivers removed from the CBA results as a way to circumvent the inflexibility of the models
Ring 3	• Primary objective is to make good connections across the S-train fingers • The public transport vision is seen as an anchoring point for the future business attraction • Anchored around the Loop City spatial vision

Figure 5: *Enrolment scheme for each of the three LRT projects, as well as the national level.*



6. The role of CBA in the decision-making processes

In order to ensure consistency between evaluations of the projects, the Danish Ministry of Transport provides a standard model for socio-economic calculations named TERESA. The purpose of this model is to facilitate the calculations in socio-economic analyses and ensure a consistent methodology when appraising transport infrastructure projects (Danish Ministry of Transport, 2015). The evaluation tool includes a standard set of quantified factors, often referred to as 'traditional effects'. For a public transport project, these include construction costs, maintenance of infrastructure, operation, ticket revenue, changes in travel time and distance, externalities (noise, emissions, accidents, etc.), and taxation effects. These effects are all assigned a monetary value based on transport economic unit prices specified by the Ministry of Transport in collaboration with the Danish Technical University. The methodology acknowledges that there are some additional effects that are difficult to quantify. In an appendix to the guidelines there is a description of alternative methods to quantify and evaluate these effects (Danish Ministry of Finance, 1999).

The interviewees at the local scale refer to CBA as an undesired burden and an obstacle for obtaining approval for funding. In general, they find that the tool is too rigid and that it fails to appreciate many of the most important benefit categories of LRT projects. The project manager for the Odense LRT project explains that:

> It is an issue that we from the beginning of the project are behind on points, instead of acknowledging that light rail is something different (…) especially with the approach we take in Odense, where we are doing urban renewals, urban densification and strategic urban development. Then, in my opinion you cannot use an infrastructure model to evaluate the benefits of this project. (Interview Odense LRT)

A similar concern is raised by the transport consultant from COWI:

> One of the challenges in the current evaluation praxis is that we want the light rail to enable urban development that would otherwise not be possible, but we cannot use different scenarios in the build and no-build alternatives. Then our traffic modelling breaks down. (Interview COWI)

In comparison, the interviewee from the Ministry of Transport refers to CBA as a necessary prioritisation tool when faced with multiple investment options and limited funding. It is acknowledged that the tool has some limitations, but there is a general reluctance towards including additional impacts, which cannot be assessed robustly, or when there is a risk of 'double counting' (Interview Ministry of Transport). It is, however, acknowledged that the scenarios in the model could be constructed differently:

> The reason light rail has poor CBA [socio-economic return] is because of the penalty imposed by displacement of cars. But this depends on your no-build scenario; if it is a political priority to limit access by car regardless of the light rail, then the no-build scenario should reflect this. (Interview Ministry of Transport)

This points to one of the fundamental problems with CBA identified by the local actors. If the no-build scenario reflects the prioritised urban development objectives, then the penalty imposed from displacement of cars ought to figure in both scenarios, and will thus not figure as a cost in the CBA. At the local scale, much effort has been made to point out these shortcomings of TERESA model. In evaluation reports, it has been pointed out that strategic values are not captured by the TERESA model, but that these factors constitute crucial rationalities behind local political decisions to implement LRT systems (Letbanesekretariatet Midttrafik, 2013; Odense Municipality, 2013b, Ringby/Letbanesamarbejdet, 2013). The gaps between the strategic arguments behind LRT and the logics of TERESA are summarised in table 4.

7. Conclusions and implications for practice

The 'translation' of LRT systems into a Danish context can be understood as processes primarily concerned with problematising and substantiating LRT as a solution to local urban development agendas. A crucial point in this translation has been the reframing of LRT as more than a transport infrastructure project. In all three decision-making processes, spatial visions have played important roles in inscribing LRT into a reality beyond socio-economic feasibility – a reality where strategic urban development and urban quality are rated as important values. At the same time, the spatial visions (and the values embedded in these) have been important in the mobilisation of political support and in the enrolment of actors in support of the LRT projects.

The ANT approach adopted in this paper has helped to shed light on the role that both human and non-human actants play in decision-making processes for large infrastructure projects. In particular, the ANT approach draws into attention the importance of non-human actants in decision-making processes on LRT systems. The paper illustrates how the technologies of LRT systems (tracks, vehicles etc.) are allowed to develop into important actants, which hold more powerful sources of action than its BRT rivals. Furthermore, the ANT approach brings into focus the important role that 'inscription devices', such as the Danish CBA model TERESA and local urban development strategies, play as 'gatekeepers' in policy debates, as well as constituting powerful actants in their own right. We argue that ANT constitutes a valuable analytical perspective for examining the complexities (human and non-human) embedded in decision-making on large infrastructure projects such as LRT systems.

Table 4: *Overview of the gaps between political and planning rationales for LRT and the logics in the Danish evaluation model TERESA. Sources: Letbanesekretariatet Midttrafik, 2013; Odense Municipality, 2013b, Ringby/Letbanesamarbejdet, 2013; Interviews: Aarhus LRT, Odense LRT, Ring3 LRT, Ministry of Transport.*

Arguments used in the decision-making processes	Logics in the Danish evaluation model TERESA
More than a transport project Wish to implement LRT is grounded in broad political/strategic urban development visions. An increased land value is a key component of such visions.	**Evaluated as a transport project** Strategic values for urban development are not included in the evaluation, which mainly focuses on travel time savings and construction costs.
Promoting public transport - reducing car traffic Strong wish to reduce car traffic in the urban core.	**Restricting car travel has a negative value** Imposing burdens on car users often result in significant benefit losses.
Restrictive supplemental policies Displacement of car traffic is a political priority in itself and not a consequence of LRT. Road contraction would be implemented even in the absence of LRT.	**The importance of the basis scenario** The no-build alternative must take a point of departure in the present situation and approved development.
LRT is more attractive than bus Comfort levels and peak capacity result in better service quality, which attracts higher patronage for rail service compared with bus service.	**No differentiation between travel time in different modes** No differentiation between the value of bus and rail travel time, but a 'rail factor' is added to the demand forecasts to account for a more attractive service.
Travel time is not lost time Time spent travelling in public transport is valuable time – it could be useful work or relax time	**Travel time is wasted time** Time spent travelling is wasted time that could have been used working or for leisure – therefore a cost for individuals and society as a whole
The LRT as a prerequisite for urban development The LRT should be the 'backbone' in the future urban development in the city and the region. This means that the LRT in many cases is the prerequisite for urban development that would otherwise not have been possible or happen in the prioritised corridors	**Hard to include estimations of urban development potential** Model cannot reflect dynamic effects on land use changes. Modellers are legally prohibited from specifying different land use developments when comparing build alternatives with no-build alternatives.
Strategic value to supplement other planning initiatives The LRT creates a new connection between the many new urban development projects happening and the important strategic destinations in the city (hospital, universities etc.)	**Strategic value is not measured** This value is not measurable and is not part of the formal analysis.
Creating new urban qualities The LRT has an 'amenity value' and an aesthetic and social value for the life lived in the city.	**Hard to quantify aesthetic value** The aesthetic value and the 'amenity value' are not included in the evaluation tool.
Providing a new image for the city and public transport The tracks are a visual feature in the cityscape - a new aesthetic element and identity creator for the city.	**Value of image is not measured** This value is not measurable and is not part of the formal analysis.
Permanency and reliability of tracks Rail-based transport has more permanency than BRT and has a strong station-proximity effect for nodal densification	**Value is not measured** Not reflected in the appraisal.
Attracting investment LRT is a prerequisite for attracting new investments from both private and public parties.	**Value is not measured** Not reflected in the appraisal.

The analysis illustrates that CBA only constitutes a part of the basis for decision-making. However, CBA remains an obligatory passage point in the preliminary stages of a project, in order to secure financial state support for part of the construction costs. In this regard, the state constitutes an important actor to enrol in the network, also in terms of stabilising local political support for the project. In all three processes, great efforts have been made to emphasise and inscribe the strategic values of the projects, not included in the CBAs, into diagrams, reports, maps etc., in order to visualise and make these values 'real' for decision-makers. In the end, the spatial visions have much more political appeal in the local decision-making processes, and are much more in sync with the local politicians' sense of reality, than the results from the CBAs.

The results from the Danish cases reflect similar findings in many other countries, where broader spatial planning agendas take priority over strict socio-economic feasibility (Culver, 2017; Higgins & Kanaroglou, 2016; King & Fischer, 2016; Lagendijk & Boertjes, 2012; Suzuki 2013). This is a phenomenon not only limited to appraisals of LRT systems. In a recent study, Sager (2016) displays how the socio-economic feasibility of Norwegian road projects does not correlate with their likelihood to obtain political approval.

This leads to important questions about the role of CBA as decision support tool for prioritising between substantially different projects. Having in mind that the CBA only constitutes a part of the basis for decision-making, a substantial amount of resources is allocated to the preparation of these appraisals. In addition, substantial attention is dedicated to improvements of the socio-economic models used in practice, including how to integrate qualitative factors of infrastructure projects. One of the greatest challenges is to account for the fact that LRT schemes are used as a means to reduce car traffic in the city, by removing roads, car lanes, and lowering travel speed. Such measures will increase the travel time for cars and therefore feature as a societal cost in CBAs. However, this is something which could be accounted for in the construction of the baseline scenario in the CBA, if local politicians are aiming to implement these measures regardless of whether the LRT project is implemented or not. In this way, the costs of increases in travel time will not feature as a cost related specifically to the LRT project. This makes the basis scenario a potential powerful tool for negotiating restrictive policies, and for mobilising political support for such measures as part of LRT projects.

It is difficult (if not impossible) to incorporate the complexity of strategic prioritisations into the practice of quantitative transport modelling. The CBA methodology already makes it difficult to ensure consistent and transparent ways of prioritising between different infrastructure projects. In order to secure transparency in these methods, it is necessary to develop simpler models where the underlying assumptions are accessible for decision-makers. Based on the limited role that the CBA plays in the decision-making processes for LRT systems in practice, it seems more appropriate to place strategic decisions in the centre of the decision-making processes, which are open for discussion and cri-

tique by all actors, rather than black box these into a complex modelling methodology. One of the problems about the current practice of including the qualitative values in decision-making processes is that this has so far not been done in any systematic way. Whereas it is quite easy to set-up measurable objectives for quantitative measures, and perform sensitivity analyses of these measures, it is a more challenging task to perform the same systematic evaluation of qualitative measures. We question if it is at all possible to develop the same systematic methodology for these measures. Nevertheless, there is a need to develop more systematic ways of securing that qualitative objectives are incorporated into the evaluation and decision-making processes for LRT and related projects. Such a qualitative methodology will allow decision-makers to make more well-informed decisions, based on factors which influence the potential of achieving qualitative effects, such as the development of new urban environments, positive image, modal shifts, behavioural change etc.

However, it is also important to acknowledge that decisions to implement LRT projects in a local context cannot be seen insolation. The experiences, narratives and discourses from other light rail cities act as important actants in the decision-making process. These reference projects play an important role in visualising and making the qualitative values of the LRT system 'real' for decision-makers. In this sense, LRT systems constitutes a 'traveling idea' (Tait & Jensen, 2007), and by subscribing to this idea (and the inherent values), cities enrol into a larger network of liveable and sustainable cities. The actor-network of light rail cities has become a powerful 'spokesperson' (Callon, 1986) for sustainable urban mobility, and for strengthening the links between land use and transport planning as a means for creating alternative futures to highly car dependent societies. It is this reality that decision-makers (and all LRT supporters) subscribe to when LRT systems are implemented – it is a reality beyond the rationality associated with socio-economic analyses.

Endnotes

[1] Light rail transit (LRT) is used here to refer to a rail-based public transportation system, often powered by electricity. LRT systems run at street level and are integrated into the street environment, unlike underground metro and suburban (heavy) railway systems. The tracks are either separated from other modes of transport in dedicated 'right-of-way' or integrated with other modes of transport. LRT is here used as a generic term for trams, streetcars or similar systems.

[2] Bus rapid transit (BRT) is used here to refer to a bus based public transportation system that, unlike conventional bus systems, has dedicated lanes separated from other modes of transport. BRT is often considered a "light" version of LRT.

[3] Light railway was also the preferred public transport system in the fourth city, Aalborg. However, the national government declined to co-finance the proposed light rail scheme, so the city decided to implement a BRT system instead.

[4] Here we understand LRT as more than a technology. Electric trams and other LRT like technologies have been around for more than a century, and these technologies have had significant impacts on urbanisation processes and the morphology of cities. What is 'new' about contemporary LRT projects is the strong association with certain values and rationalities, e.g. sustainable mobility, transit-oriented urban development, liveability and economic growth. It is these values and the network of cities, which have adopted

these values, that cities subscribe to when they implement LRT projects. It is in this understanding that we conceptualise LRT as a 'travelling idea'.

[5] Note that the criticism presented here is directed towards CBA as a tool to prioritise among projects that are conceptually different, such as LRT and BRT. CBA remains a useful tool to prioritise between projects that are conceptually very similar, such as two parallel LRT alignments that are expected to offer similar urban development prospects.

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