

Nudging to Promote Active Transport

The interrelatedness of nudges, barriers and promoters in public policy interventions promoting active transport in Aarhus

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Abstract

Our cities are growing and so are the challenges that urbanisation has brought about in the transport area. Many levels of government recognise the need for public policies that encourage active transport to prevent the negative impacts of motorised transport on the environment and health. In this regard, peopleoriented mobility plans and behavioural science tools for changing people's behaviour in pursuit of policy objectives are gaining ground.

This thesis seeks to uncover how nudges and barriers and promoters are interrelated in and influence the application of public policy interventions promoting active transport by applying a conceptual framework composed of types of nudges, barriers and promoters and the social-ecological model. Taking a point of departure on a literature review comprising existing literature within the field of active transport and behavioural interventions this study is carried out as a qualitative case study based on the experiences of the Mobility Teams in Aarhus Municipality. The Mobility Team's primary task is to contribute with behaviourally informed nuances and approaches to the traditional infrastructure and urban planning projects. The collected data include case-specific and expert interviews besides case documents covering active transport interventions applied by the Mobility Team. The findings of this study suggest that various types of nudges and structural and specific barriers and promoters are interrelated at multiple levels of influence in clusters of patterns of relatedness based on target group size and overall patterns of relatedness across active transport interventions. The study further indicates that the Mobility Team is caught in a negative feedback loop where they cannot engage in large-scale and long-term active transport interventions.

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1. Introduction

Our cities are growing and so are the challenges that urbanisation has brought about in the transport area. Today, around 50 pct. of the world's population live in urban areas. A proportion projected to increase to 68 pct. by 2050. With an increase in transportation and commuting brought by the urbanisation, a rising energy bill, emissions, air pollution, traffic accidents and congestion have become a great matter of concern for public policy (Interreg Europe, 2018; World Bank, 2014; IPCC, n.d.; European Commission, 2016). Urban areas have a great challenge promoting effective, safe and sustainable urban mobility (World Bank, 2014).

Many levels of governments around the world are recognising the need for public policies that encourage active transport, such as bicycling and walking (Handy, VanWee, & Kroesen, 2014; OECD, 2017), to prevent the negative impacts of motorised transport on the environment and health (WHO, 2010; Kahlmeier, et al., 2011; Saunders, Green, Petticrew, Steinbach, & Roberts, 2013). Governments are starting to establish urban mobility plans that have shifted from the traditional, infrastructure-oriented approach towards sustainable and people-oriented planning (Böhler-Baedeker, Kost, & Merforth, 2014; Cirianni, Monterosso, Panuccio, & Rindone, 2018). In this regard, governments and public institutions are increasingly adopting behavioural science tools for changing people's behaviour in pursuit of policy objectives (Afif, Islan, Calvo-Gonzalez, & Dalton, 2019; OECD, 2017; Thaler & Sunstein, 2008).

Holding a bachelor's degree in sports science and finishing a master's degree in business administration and economics, exploring public policy interventions to promote active transport was an obvious opportunity to combine my fields of interests. More specifically, looking at how to increase people's physical activity level from an economic point of view. As an entry point into this field of knowledge, I did a literature review focusing on interventions promoting bicycling and walking through nudges and changes in the choice architecture. The literature review constitutes two parts, one focusing on interventions worldwide and the other on Danish interventions. The literature review reveals that interventions are manifold and often effective; however, not showing consistent effects. Hereto, several barriers to and promoters of active transport interventions were identified.

Interventions are policy initiatives and aim at steering people's behaviour in a certain direction. An empirical intervention is often a sum of several *nudges*. A nudge, as defined by Thaler and Sunstein (2008), implies a shift in the design of the *choice architecture* – the way in which choices are presented or framed. While trying to steer people in a certain direction, nudging still holds an

incentive to preserve the freedom of choice and not significantly change people's economic incentives (Thaler & Sunstein, 2008). By designing aspects of the context in which decisions are made, mobility planners and other transportation professionals can adopt the role *choice architect*, characterised by Thaler and Sunstein (2008).

Changes in the choice architecture are, in principle, as the literature review indicates, an effective approach to promote active transport. But urban transport planning targeting human behaviour is complex and often associated with multiple barriers and promoters (Nieuwenhuijsen, 2016). Consequently, to investigate active transport interventions, one needs to incorporate various factors at multiple levels to unfold the complexity (Sallis & Owen, 2002). The *social-ecological model* presented by Larouche and Ghekiere (2018) emphasises that human behaviour is influenced by multiple interrelated factors at five levels: *individual, interpersonal, community, built environment* and *policy*. To conclude, in order to understand how people are 'nudged' and developed, and the barriers and promoters that affect this, the entire ecological system including the multiple layers of the social and physical environment needs to be taken into account.

The Case: Nudging to Promote Active Transportation in Aarhus Municipality

This master's thesis presents a case study of active transport interventions initiated by a team in the Department of Urban Development and Mobility (henceforth, the Mobility Team) at Aarhus Municipality. Aarhus is the second-largest city in Denmark and expects to grow by 50,000 inhabitants over the next 15 years. Recognising a need to approach mobility challenges from new perspectives, in 2014, the Mobility Team initiated interventions to change Aarhusians' transport behaviour. More specifically, the interventions encouraged Aarhusians to bicycle or walk instead of using motorised modes of transport.

1.1 Research Question

This study is designed to address the following research question and sub-questions.

Research Question

• How are nudges and barriers and promoters interrelated in and influence the application of public policy interventions promoting active transport?

Sub-questions

- 1. What types of nudges are applied in the active transport interventions by the Mobility Team in Aarhus?
- 2. What barriers and promoters are the Mobility Team in Aarhus Municipality experiencing while implementing the nudges?
- 3. At what levels of influence are different types of nudges related to barriers and promoters in the active transport interventions applied by the Mobility Team in Aarhus?

Sub-question 1 is explored by the use of Sunstein's (2014) list of the ten most important nudges for public policy planning. Sub-question 2 is empirically driven and investigated through context-dependent categories. Finally, sub-question 3 is examined by employing the social-ecological model as presented by Larouche and Ghekiere (2018). The social-ecological model is used to investigate active transport promotion from a multi-level perspective and to enhance the understanding of nudge application in active transport interventions. The findings are structured according to the sub-questions so that sub-question 1 is presented in findings part 1 and so on.

1.1.1 Concept Clarifications

In the following, terms and concepts essential for the understanding of this study are briefly defined.

- Active transport: Includes non-motorised forms of transport involving physical activity: walking and bicycling.
- Aarhus: Refers to the city of Aarhus and covers the urban area, including the suburban areas comprising the municipality.
- Aarhus Municipality: The term is applied when describing the administrative and political entity constituting Aarhus Municipality, this is the governance of Aarhus with Aarhus Municipality as an employer.

- Aarhusians: Citizens of Aarhus.
- **Barrier:** Encompassing anything used or acting to prevent or challenge someone from doing something or to prevent or challenge something from happening. The barriers are empirically derived.
- Interventions: All interventions addressed in this study are active transport interventions, henceforth interventions. The interventions consist of the Smart Mobility project (ten interventions) and the Cycle Superhighways project (one intervention). Generally speaking, interventions are policy initiatives designed on previously behavioural evidence behavioural insights or based on new experiments to change people's behaviour. Nudges and changes to the physical environment are to be understood as 'soft' policy tools (non-restrictive) and as such, building blocks of interventions.
- **Promoter:** Encompassing anything used or acting to support or enable someone from doing something or to support or enable something from happening. The promoters are empirically derived.
- The Department of Urban Development and Mobility: The Department is found under the magistrate unit Urban Development, Construction and Environment. The department of Urban Development and Mobility is divided into two work areas: operation and mobility. This thesis is focused on the work area of mobility. Still, for the sake of simplicity, I do not differentiate between the two work areas and simply refer to the Department of Urban Development and Mobility.
- The Mobility Team: Is situated within the Department of Urban Development and Mobility and focuses on behavioural active transport interventions (interventions). The Mobility Team includes Liv, Gustav and Charlotte, i.e. choice architects.

1.1 Master's Thesis Structure

This section provides an overview of the structure of this master's thesis.

Figure 1: Master's Thesis Structure

 Introduction Literature Review 	 1.1. Introduction 1.2 Research Question 1.2 The empirical Setting 2.1 Part 1 – Worldwide 2.2 Part 2 – Denmark 		
3. Theoretical Framing	3.1 Theoretical Underlying Aspects3.2 Conceptual Framework		
4. Methodology	 4.1 Philosophy of Science – Pragmatism 4.2 Research Design – A Case Study 4.3 Data Collection: Primary and Secondary Data 4.4 Data Analysis Process 4.5 Quality of the Study 		
5. Findings	Part 1Types of NudgesPart 2Barriers and PromotersPart 3Levels of influence and relations between nudges, barriers and promoters in interventions		
6. Discussion	Interrelatedness and influence of nudges, barriers and promoters in the application of public policy interventions to promote active transport		
7. Concluding Remarks	7.1 Managerial Implications 7.2 Future Research		

1.3 The Empirical Setting

50,000 more Inhabitants and Carbon Neutrality in 2030

Aarhus has 350.000 inhabitants (Aarhus Kommune, 2020) and already has an extensive public transportation system consisting of a big bus network, train and tramline (Business Aarhus, n.d.). However, Aarhus City Council has set an ambitious urban development plan. Over the next 15 years, Aarhus must grow by 50,000 inhabitants and 30,000 jobs and study places, and at the same time, Aarhus set out to be carbon-neutral in 2030. The Department of Urban Development, Construction and Environment plays a central role in this plan (Aarhus Kommune, n.d.). Aarhus is already struggling with congestion during peak hours (Aarhus Kommune, 2018) as car traffic has increased by six pct. in the last ten years (Aarhus Kommune, n.d.). Aarhus is transforming. If the citizens' transport behaviour is not altered, 20,000 more cars will be driving on the roads of Aarhus, which will lead to increased congestion and lack of parking spaces. At the same time, the environment and urban life are negatively impacted by the dense traffic (Aarhus Kommune, 2018).

The Organisational Setting of the Mobility Team

Aarhus City Council is the municipal government consisting of 31 members elected every fourth year. The administration of Aarhus is organised around six units, which constitute the magistrate (see Figure 2). The magistrate is led by the councilman, five councillors and three magistrate members. One of the six units is Urban Development, Construction and Environment under which the Department of Urban Development and Mobility is found. (Aarhus Kommune, n.d.).

Figure 2: Organisation Structure of Aarhus Municipality



The Department of Urban Development and Mobility is responsible for planning the traffic and infrastructure in Aarhus, expanding the road network and ensuring that asphalt, traffic lights and parking work on the existing streets and roads. Moreover, the Department of Urban Development and Mobility develops local communities and work to give the citizens a pleasant experience with well-kept paths, trees and plants in the city's green areas (Aarhus Kommune, n.d.). The Department of Urban Development and Mobility continuously formulates mobility plans that guide their work. The mobility plans should support and interact with other policy plans formulated in Aarhus Municipality (Aarhus Kommune, 2018).

Within the Department of Urban Development and Mobility, a team, the Mobility Team, is situated focusing on behavioural interventions. The Mobility Team consists of three people: Liv – anthropologist, Gustav – urban design and urban planning engineer, and Charlotte – landscape architect. Initially, the team started as the project group for the Smart Mobility project, but are now permanently employed into the Department of Urban Development and Mobility where they contribute with behaviourally informed nuances or approaches to the traditional infrastructure and urban planning projects.

Project 1 – The Cycle Superhighways Project

To promote bicycling as an alternative to motorised transport, the Department of Urban Development and Mobility initiated Aarhus Bicycle Action plan for the period 2017-2021. The overall objectives of the bicycle action plan are to increase bicycle traffic by 20 pct., ensure that more than 70 pct. of cyclists are satisfied with the cycling conditions in Aarhus and bicycle traffic accidents must decrease by 25 pct. (Aarhus Kommune, 2017). The main focus of the Bicycle Action plan is the Cycle Superhighways project extending an existing cycle route with two additional routes to a cycle route network. The supplementing focus areas ensure comfort, accessibility and safety (Aarhus Kommune, 2017). The physical infrastructure of the Cycle Superhighways project overran the budget and money allocated to promotional activities was brought in to cover the costs (i1).

Project 2 – The Smart Mobility Project

The Smart Mobility project was initiated in April 2014 as a way to counter the traffic infrastructure challenges in Aarhus from new perspectives and with other methods. Smart Mobility was a funded innovation and development project within the Department of Urban Development and Mobility projected for four years running until April 2018. The overall goal was to develop, test and evaluate different cost-effective means and methods to influence Aarhusians' transport behaviour and create awareness about the need for healthier and more sustainable choices in terms of active transportation modes. The methods

were 'soft tools', and the experiences learned should, in the long run, enable the Department of Urban Development and Mobility to implement alternative initiatives on an informed basis (Smart Mobilitet, 2018).

As mentioned earlier, the Mobility Team, Liv, Gustav and Charlotte, also make up the three project members of the Smart Mobility project. During the project, the team was given free rein within the scope, timeframe and resources of the project besides the overall objectives of Aarhus Municipality (Smart Mobilitet, 2018, 2017; i1).

Target Groups

The main target groups of the Smart Mobility project were residents in the suburb Beder-Malling (counting 10,000 inhabitants), 250 employees in the Department of Urban Development, Construction and Environment, schoolchildren and Aarhusians in general. During the project period, the Smart Mobility project carried out surveys on transportation habits and personal values to gain behavioural insights on the target groups. The vast majority of Smart Mobility project resources were used in projects carried out in Beder-Malling. The Mobility Team assessed that interventions promoting active and sustainable transport are more needed in the suburban part of Aarhus than in the city centre of Aarhus because many suburban residents commute into Aarhus (i1). Families with small children moving out of Aarhus city usually acquire one or two cars and are viewed to be the ones that fill the motorised infrastructure system of Aarhus the most and therefore must be encouraged to change behaviour (i1).

Active Transport Interventions

Between 2014 and 2018, the Smart Mobility project planned, designed, implemented and evaluated 22 habit-breaking interventions (Smart Mobilitet, 2018) The 22 interventions focused on walking, bicycling, public transport, car-pooling, shared car, work at home, work flexible hours and various combinations hereof (Smart Mobilitet, 2018). Ten of these 22 interventions focused solely on initiatives aimed at encouraging participants to choose active modes of transport – bicycling and walking. The strategy of the interventions included organisation, coordination, information and communication designed on knowledge about the target groups' needs, requests, challenges and motivations to change transport habits (Smart Mobilitet, 2018)

The ten active transport interventions from the Smart Mobility project together with the Cycle Superhighways project are listed in Table 1 with a short description of the intervention design. A full overview of the interventions, including design participants, duration, aim, evaluation method and outcome is presented in Appendix 1.

 Table 1: Active Transport Interventions in Aarhus Municipality

Project	Design and strategy	Duration	
Residents from Beder-Malling			
365 Days By Bike (1)	Thirty-five motivated participants tested electric bicycles or their own bicycle as the primary means of transport for commuting to work. They were supported by a tracking app, bicycle maintenance, health measurements, competitions, campaign jackets etc.	April 2015 – April 2016	
In Tailwind and Headwind (2)	Five married couples borrowed electric bicycles and tested them on their daily commutes instead of driving by car. Employed bicycle maintenance, travel diary in local newspapers and radio and campaign jackets	May 1st 2017 – October 30th 2017	
Super Commuters (3)	Participants replaced their car with a folding bicycle and monthly cards for bus and train to test mixed-mode travel. Participants received campaign jackets and shared stories.	September 9 th 2015 – December 9 th 2015	
	Active School Transport		
Walking School bus (4)	Students from grade 0-5 at four schools (two in Beder-Malling), chaperoned by the older students, walk to school along a fixed route with four to five stops (partnership with Trygfonden and Dansk Skoleidræt)	April 2015 – December 2017	
The Traffic Snake Game (5)	A European travel to school campaign where students in grade 0-3 at four schools (two in Beder-Malling) put dots on a Traffic Snake banner every time they cycle, walk, use public transport or carpool to school to see if they met pre-set class goals. The campaign was supported with competitions.	April – May 2015 April – May 2016	
	Work-based Intervention		
Visible Electric Bicycles (6)	Company electric bicycles were available for 250 employees in Aarhus municipality to bike during working hours as an alternative to taking a company car. The electric bicycles were parked at the main entrance of the workplace.	May 2015 – June 2015	
	Aarhus citizens		
City Bike Trailers (7)	Fifty city bike trailers were free to pick up from Aarhus City Bike (bicycle sharing system) dock stations and return after use. Compatible with own bicycles.	April – October 2016 April – October 2017	
Bicycle Library (8)	The mobile bicycle library lent speciality bicycles (e.g. electric bicycle, folding bike, lightweight bike) to Aarhusians as an everyday bike for up to seven days.	August 2015 – December 2017	
Get Cycling (9)	A partnership project motivating Aarhusians to choose the bicycle on short trips (< 5 km). The campaign was supported by a <i>Cycle-</i> <i>Coach-app</i> , bicycle service and local events.	March 2015 - June 2017	
Park and bike Terminal (10)	Two parking facilities located close to radial roads, the Aarhus light rail and the Cycle Superhighways enabling mixed mode trips. Commuters can rent locked parking booths to leave the bike overnight.	Constructed: 2015 - 2017	
Cycle Superhighways (11)	Cycling route network connecting the city centre with the surrounding areas. The Cycle Superhighway is connected to the light train stations and Park & Bike Terminals.	Constructed: 2016 - 2019	

1.3.1 Delimitations to case

Temporal

In terms of the time aspect, this study addresses the period from 2014 when the Smart Mobility project was initiated and until now where the experiences from the Smart Mobility project is employed in new active transport interventions. One of the Cycle Superhighways segments were built from 2009 to 2012. However, the two routes that I am focusing on were constructed from 2016-2019, and it is only in these two that the Mobility Team were involved. The line I draw between the time before and after 2014 is a contextual choice. In 2014 the Department of Urban Development and Mobility acknowledged the need for alternative approaches to urban mobility planning and as such 2014 can be said to constitute the beginning of deliberate use of 'soft tools'.

In a political organisation as Aarhus Municipality, organisational restructuring happens from time to time. Aarhus Municipality was in the middle of an organisation restructure during the time I conducted the first interview with Liv (i1). I refer to the present organisational structure throughout the study. Even though the active transport interventions presented were carried out in the past, the Department of Urban Development and Mobility still encompasses the same employees as before the restructuring (i1).

Spatial Delimitations

The interventions in Beder-Malling and the active school transport interventions are more rich in their descriptions in the findings as these were highlighted the most by Liv during the interviews and most of the Smart Mobility budget was spend on these interventions. Nevertheless, I found it essential to include all 11 active transport interventions to provide the contextual background to unfold the complexity of the case. Furthermore, most of the active transport interventions included in the case describe bicycling as an alternative mode of transport, except for the active school transport interventions. Walking is also considered to be a mode of active transportation. However, one possible explanation of the lack of focus on pedestrian interventions is that the pedestrian action plan for Aarhus Municipality is still being drawn up, but has not yet been initiated (i1).

Promoting active transport and mobility planning, in general, involves multiple sectors and stakeholders. This thesis provides a study of the complexity of applying nudge applications to stimulate active transport from the *perspective* of the Mobility Team, i.e. the choice architects (Liv, Gustav and Charlotte). Additional stakeholders, e.g. target groups or partners, involved in active transport interventions in Aarhus, are brought into play when emphasised in the case data but are not elaborated further. The urban mobility policies carried out in the Department of Urban Development and Mobility emanate from and

follow the directions of Aarhus Municipality's overall visions and policies in the other magistrate units. This thesis does not relate to the content of these policies either.

2. Literature Review

As presented in the introduction, I did a literature review as an entry point into the field of interventions employing nudges and choice architecture changes to promote active transport.

The literature review consists of two parts. The first part is an overview of eight systematic reviews on worldwide interventions promoting active transport through behavioural strategies. This part was conducted using a distinct search strategy with defined keywords followed by a thorough screening process deploying predetermined inclusion and exclusion criteria. The second part is a hand-searched review of Danish interventions for active transport promotion and includes both scientific articles and grey papers. The literature on Danish interventions is somewhat limited. Therefore the method of conducting this part followed a snowball approach – both backwards (what publications are cited in the given paper) and forwards (which publications have cited the given publication) (Wohlin, 2014). A detailed description of the literature review methodology can be found in Appendix 2.

Both parts of the review take a narrative approach to cite results and conclusions extracted from the literature search. The results of the literature, in its full length, is found in Appendix 2. The results are structured in paragraphs containing the same intervention characteristics in terms of targeting a specific group of participants: workplace-based, active school transport and population-based. Within these paragraphs, the interventions are divided into sections categorised according to the particular mode of transportation and the type of intervention strategy (changes to the social environment or physical environment).

In the following section, the results of the literature review are summarised for the worldwide and Danish interventions, respectively, and a brief discussion of the results is provided.

2.2 Part 1 – Worldwide

Overall, the literature reviews of worldwide interventions show mixed results of interventions for promoting active transport. In the two systematic reviews by Ogilvie et al. (2004) and Scheepers et al. (2014) concerning a mode shift from car to active modes of transport, most of the studies showed a positive effect on a change in behaviour and these applied targeted behaviour change programmes or more than one intervention tool. Foster et al. (2018) showed some positive results of interventions promoting walking through changes in the social and physical environment. Three systematic reviews by Pang et al. (2017), Larouche et al. (2018) and Villa-González et al. (2018) on interventions for promoting active

school transport showed mixed results. Finally, in the two systematic reviews by Pucher et al. (2010) and Fraser and Lock (2010), some positive associations between cycle promotion interventions and levels of bicycling was found pointing at comprehensive behaviour change programmes and changes in the physical environment to be effective interventionstools.

There was substantial heterogeneity across studies included in the systematic reviews in terms of study designs, sample size, interventions, outcome measures and analytical approaches. Moreover, the quality assessment for the studies was generally low. As a result of the heterogeneity of studies, it was not possible to derive any generalisable conclusions on which types of interventions affect a specific target group and why. But active transport interventions combining intervention tools, including comprehensive programmes or targeted behaviour change programmes generally showed to increase in bicycling and walking levels.

The results of the overview are summarised in Table 2. Due to the heterogeneity of studies, the table simply presents the various intervention tools applied in the studies and do not approach if the given intervention tool had a positive effect or no effect on active travel behaviour. Table 2 also lists promoters and barriers found to influence participants travel behaviour only including those covered in the systematic reviews.

Table 2: Intervention Tools Worldwide

Intervention tools – worldwide:			
 Intervention tools: Information and communication (e.g. maps, puncture workshops, information, timetables, route planning, cycle storage, distance graphics)	 Promoters: Short trip distance & & & Collaboration with stakeholders (e.g. teachers, parents and local police) & Parental support & School transport policies & Bicycle access & Individualised promotion & Perception of safety & Barriers: Long trip distance & Traffic danger/perception of safety & Sloping terrain & 		

Explanation: Interventions worldwide aimed at promoting bicycling ($\overset{\circ}{\sim}$), walking ($\overset{\circ}{\otimes}$), active school transport ($\overset{\circ}{\sim}$) and active transport to work include both bicycling and walking.

2.2 Part 2 – Denmark

The review of Danish interventions to promote active transport is characterised by few contributions, more specifically from the biggest cities in Denmark: Copenhagen, Aarhus and Odense. All three cities have adopted mobility plans encompassing a variety of intervention tools to increase the number of trips done by bicycle or walking. Overall, the programmes seem to increase the level of active

transport, but the interventions are heterogenous and evaluations are based on population-based transport habit surveys and do not specifically address the initiatives.

The results of the Danish interventions are summarised in Table 3. Due to the heterogeneity of studies, the table simply presents the various intervention tools applied in the studies and do not approach if the given intervention tool had a positive effect or no effect on active travel behaviour. Table 3 also lists promoters and barriers found to influence participants travel behaviour only including those covered in the systematic reviews.

Table 3: List of intervention tools from the review on Danish interventions to promote active transport

Intervention tools - Denmark			
Intervention tools: Information and communication (e.g. interactive information boards, route planning, graphics) Incentives (e.g. competition, win prices) Promotional activities (Incentives) 	 Denmark Promoters: Public involvement in bicycle planning A Restrictions on car use (e.g. road and parking capacity limitations and automobile speed limitations in cities) A Land-use policies A 		
 Bicycle access (e.g. rental systems) A Traffic control changes (e.g. green waves, right-hand turn against the red light) A Bike tracks salted during winter A Separation from traffic (e.g. bicycle streets, road surface) A 	 Safety A Promoters: Safety A The Danish School reform A 		
 Expansion of bicycle tracks A Cycle route networks A Bike paths A Bicycle parking spaces A Footrests for cyclists A Tilted litter bins A 			

Interventions in Denmark aimed at promoting bicycling ($\overset{()}{\sim}$), walking ($\overset{()}{\otimes}$), active school transport ($\overset{()}{\cong}$) and active transport to work ($\overset{()}{\cong}$). Active school transport and active transport to work includes both bicycling and walking

3. Theoretical Framing

In the following, I start by presenting the underlying theoretical aspects contributing to the conceptual frameworks of nudging and choice architecture. After that, I present the theories applied in the conceptual framework of this thesis: choice architecture, nudging and the social-ecological model.

3.1 Theoretical Underlying Aspects

The contribution to behavioural insights, which are used as a complementary tool to traditional policy instruments, comes from numerous disciplines of behavioural sciences like behavioural economics, cognitive and social psychology (European Commission, n.d.). These will briefly be elaborated below. Furthermore, the use of behavioural insights in public policy is explained.

3.1.1 Behavioural Economics

Behavioural economics gained ground in the 1970s (Kapeliushnikovab, 2015). No single agreed definition of behavioural economics exists, but its origin lies in the crossroads of economics and psychology – to a wide extent methods from experimental psychology (Lunn, 2014; Kapeliushnikovab, 2015). From its beginning, behavioural economics has challenged the classic economic theory that has long been dominated by the rational behaviour model in which *economic man* – also known as *homo economicus* – is an idealised human being who acts rationally and with complete knowledge. This assumption implies that economic man makes decisions in a self-interested way based on utility and profit maximisation (Hollis & Nell, 1975). Empirical evidence has provided behavioural insights questioning human rationality in decision-making. Moreover, behavioural science has demonstrated that people are subject to behavioural biases and often rely on mental shortcuts and habits in decision-making (Tversky & Kahneman, 1974).

3.1.2 Cognitive and Social Psychology

Tversky and Kahneman (1974) introduced a view on human nature characterised by being affected by heuristics and cognitive biases. According to the two authors, heuristics and cognitive biases help explain why people do not act entirely rational: "people rely on a limited number of heuristic principles which reduce the complex tasks of assessing probabilities and predicting values to simpler judgemental operations. In general, these heuristics are quite useful, but sometimes they lead to severe and systematic errors" (Tversky & Kahneman, 1974: 1124).

Based on these insights, psychologists suggest that the human mind contains two cognitive systems – one that is automatic (system 1) and one that is reflective (system 2) (Thaler & Sunstein, 2008). System 1 operates intuitively and automatically, with little or no effort of *thinking*. When determining if an object is close or far away, system 1 is in charge. System 2 is reflective and rational and focuses attention on the effortful mental activities that require it. The system is, for example, used for computations or to decide which route to take for a road trip. As such, "[...] the Automatic System is your gut reaction, and the Reflective System is your conscious thought" (Thaler & Sunstein, 2008: 21).

Heuristics and biases emerge from the interaction between system 1 and system 2 and can be understood as rules of thumb (Thaler & Sunstein, 2008, pp. 22-23) or mental shortcuts (Policy Horizons Canada, 2017; Sunstein, 2013) that help people make decisions. When facing a difficult question, system 2 would work hard to figure it out, but system 1 takes over by thinking of an easier question relevant to the difficult one, and the easy question is answered instead (Sunstein, 2013). People live busy and complicated lives and are constantly faced with information overload that does not allow for time to think and analyse before every decision. Therefore people resort to heuristics – or rules of thumb – when something must be judged (Thaler & Sunstein, 2008). Tversky & Kahneman (1974) identified three main heuristics in their original work: *representativeness, anchoring* and *availability* – and the biases associated with these. The representativeness heuristic explains people's tendency to evaluate probability from a similarity criterion – stereotyping (Tversky & Kahneman, 1974). The anchoring effect stems from people's tendency to guess and estimate on the basis of existing knowledge – an anchor – and adjust in the direction that is found appropriate to the current situation (Kahneman, 2011; Thaler & Sunstein, 2008). The availability heuristic refers to situations in which people assess the probability of an event or the likelihood of risks by the ease with which examples or instances come to mind (Tversky & Kahneman, 1974).

3.1.3 From Behavioural Insights to Public Policies

Thaler (2015) addresses the heuristics as mentioned above and biases concerning public policies. He points out how economic policies fail because they are rooted in classic economic theory and thus overlook critical, descriptive data based on how people *actually* behave or make decisions instead of normative 'rational actor' theories. He sarcastically terms such data *Supposedly Irrelevant Factors*. Examples of supposedly irrelevant factors include that people's choices are influenced by the *power of inertia* (a strong desire to stick with current holdings), *framing* (how information is presented), *present bias* (preference of now over tomorrow) and *conformity bias* (a tendency to 'follow the herd') (Thaler & Sunstein, 2008; Sunstein, 2013; Thaler, 2015). The behavioural insights of heuristics and biases and thereby the supposedly irrelevant factors can help explain people's irrational behaviour and decision-

making, and at the same time provide suggestions on how to de-bias people to promote the desired behaviour.

3.1.3.1 Libertarian Paternalism

In recent years, policymakers have employed behavioural insights for numerous purposes towards creating a broad behavioural public policy approach (Oliver, 2017). Two of the main advocates of these efforts are Thaler and Sunstein (2008). They argue that these behavioural insights should be applied as nudges and choice architecture from the perspective of libertarian paternalism (Thaler & Sunstein, 2008).

The concept of *libertarian paternalism* act as a basis for choice architects to work actively to influence human behaviour. Libertarian paternalism is a combination of two contradicting terms that however make sense to each other (Thaler & Sunstein, 2008). The libertarian aspect lies in the perception, that, people should be 'free to choose' and argue that policies should be designed to "[...] maintain or increase freedom of choice" (Thaler & Sunstein, 2008: 5). The paternalistic part of the concept lies in the entitlement of choice architects to "[...] influence choices in a way that will make choosers better off, as judged by themselves" (Thaler & Sunstein, 2008: 5). Consequently, libertarian paternalism is a "[...] relatively weak, soft, and nonintrusive type of paternalism because choices are not blocked, fenced off, or significantly burdened" (Thaler & Sunstein, 2008: 5); a type of paternalism where policymakers aim towards making people happier, healthier and richer (Thaler & Sunstein, 2008)

3.2 Conceptual Framework

This section comprises the conceptual framework of this thesis, including choice architecture, nudging (counting types of nudges), and the social-ecological model. It is built on Thaler and Sunstein's (2008) conceptual framework on how behavioural insights might be applied to public policy by the uses of nudges and choice architecture and the social-ecological model (Larouche & Ghekiere, 2018) taking a multi-level view on active transport behaviour.

3.2.1 Choice Architecture

The foundation of the nudge approach is that behavioural insights of people's actual behaviour and decision-making are used to redesign the environment – choice architecture – that people are surrounded by, to align their automatic decisions with reflective preferences (Oliver, 2017).

The environment in which individuals make decisions influence the choices they make. Organising the social and physical environment in which people make their choices are called *choice architecture*, a term coined by Thaler and Sunstein (2008). Choice architecture refers to the framing or presentation of choice options. It can be defined as "the design of the social environment in a way that influences people's choices, e.g. by providing information, by affecting ease or accessibility, or by making certain features of the situation salient and clear or instead invisible" (Sunstein, 2013: 37). For example, designing a staircase with motivational health-related messages on the steps and stairway walls can motivate people to skip the elevator and take the stairs. Choice architecture is ubiquitous. Sunstein (2013) argues, that "it is not possible to dispense with a social environment, and hence choice architecture is an inevitable (though often visible) part of our lives" (Sunstein, 2013: 9).

A *choice architect* is the person behind the design of choice architecture and therefore "[...] has the responsibility for organising the context in which people make decisions" (Thaler & Sunstein, 2008, s. 3). As choice architects nudge people, they are part of advancing simplicity or complexity, and their designs might complicate things for people or make them easier.

3.2.3 Nudges

Choice architects, as described above, are deliberately trying to move people in directions that improve their lives. In other words, they nudge. Thaler and Sunstein (2008) define a nudge as "[...] any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid" (p. 6). Nudges, in line with libertarian paternalism, seek to steer people in certain directions that make them better off while maintaining freedom of choice and not imposing extra costs. Nudges are designed to influence people's automatic systems (system 1) and thus, how people intuitively make decisions (Oliver, 2017). With lots of repetition, the automatic system can be trained, e.g. like stopping for the red light. Thaler and Sunstein (2008) suggest: "If people can rely on their Automatic Systems [...] their lives should be easier, better and longer" (p. 22). In continuation, Thaler and Sunstein (2008) argue "[...] people will need nudges for decisions that are difficult and rare, for which they do not get prompt feedback, and when they have trouble translating aspects of the situation into terms that they can easily understand" (Thaler & Sunstein, 2008: 72).

Nudges can be categorised into numerous types of nudges. Sunstein (2014) proposes a list of the ten most important types of nudges for purposes of policy. These are elaborated in Table 4. In continuation of the ten most important types of nudges, the conceptual framework used in this thesis adds an additional type

of nudge – built environment. As Thaler and Sunstein (2008) define nudges to be any aspect of the choice architecture that alters people's behaviour in a predictable way, the built environment can be defined as a nudge. The choice of including built environment as a nudge stems from the data analysis, which is further explained in the methodology section. The built environment nudge is therefore added as number 11 in Table 4.

Type of Nudge	Definition	Example	
Default rules	Pre-set courses of action that commence if the decision-maker does nothing.	Automatic enrolment in programs, including health, savings and education.	
Simplification	Secures that forms and programs are easily navigable and intuitive.	The Healthy Eating Plate	
Uses of social norms	Informs people about a certain behaviour that most people engage in to utilise social influence.	"Most people pay their taxes on time.", "Nine out of ten hotel guests reuse their towel."	
Increases in ease and convenience	Reduces various barriers (perceived difficulty or ambiguity) to help promote certain behaviour.	Making low-cost options or healthy foods visible.	
Disclosure and transparency	Provides understandable, accessible and simple information to help people make informed decisions	Economic costs associated with energy use, nutrition facts labels.	
Warnings, graphic or otherwise	Triggers people's attention and may increase the probability that people will pay attention in the long run.	Pictures on cigarette packages	
Pre-commitment strategies	Strategies that pre-commit people to engage in a certain action.	A smoking cessation program	
Reminders	Help counteract people's inertia, procrastination, competing obligations and forgetfulness.	Reminders on overdue bills or doctor's appointment	
Trigger intentions to change	Tries to motivate people to engage in the activity by eliciting their implementation intentions	Questions about future conduct, "do you plan to vaccinate your child?" or "do you plan to vote?"	
Feedback on earlier choices	Provides information about the nature and consequences of past choices can make behaviour shift	Expenditures on health care or electric bills.	
Built environment	The design of the built environment tries to encourage people to be active in daily life routines.	Bicycle lane separated from traffic, a pedestrian bridge over highly trafficked roads.	

 Table 4: Types of Nudges for Purposes of Policy

3.2.4 The Social-Ecological Model

The social-ecological approach was introduced by Bronfenbrenner (1979) as a conceptual model encompassing the complexity of the multiple factors influencing human behaviour and their interactions. Since, researchers within the fields of physical activity and health promotion have generously adopted the model (Larouche & Ghekiere, 2018; McLeroy, Bibeau, Steckler, & Glanz, 1988).

The social-ecological model emphasises multiple levels of influence and the idea that behaviour both shapes and is shaped by the social environment (Larouche & Ghekiere, 2018; Sallis et al., 2006). The levels of influence range from the most proximal factors (individual) to the most distal factors (policy) (Sallis et al., 2006). The most proximal levels are hypothesised to have the most significant impact on people's active transportation habits (Mertens & Ghekiere, 2018). This study adopts the five levels of influence used by Ghekiere & Larouche (2018): individual, interpersonal, community, built environment and policy (see Figure 3).

Figure 3: The Social-Ecological Model



Literature suggests correlates of active transportation at the individual level to include age, gender and attitudes such as capabilities and motivation to change (Mertens & Ghekiere, 2018). The interpersonal level is concerned with an individual's relationship with other people, like family and friends (Egli et al., 2018). At the community level, influential factors include among others social norms, school policies, social cohesion and cultural values (Larouche, 2018). The built environment level covers influences of the built physical environment, which also includes urban planning, and design and street-level attributes (Timperio, Veitch, & Sahlqvist, 2018). The most distal level of influence, policy, encompasses policies affecting people's active transportation like national policies, municipal policies, speed limits and zoning bylaw (Larouche & Saidla, 2018). In theory, multi-level interventions may be most effective in promoting active transport (Larouche & Ghekiere, 2018).

3.3 Application of Conceptual Framework

Based on the introduction of choice architecture, nudges and the social-ecological model, Table 5 presents the conceptual framework applied in the findings. The conceptual framework helps understand the empirical data and is the lens through which the research questions are investigated. The conceptual framework is a result of an iterative process of moving back and forth between empirical data and theory through abductive reasoning.





4. Methodology

In the following sections, I introduce pragmatism, the underlying philosophy of science of this study, the overall research design, data collection methods, my approach to data analysis and the quality criteria to this study.

4.1 Philosophy of Science – Pragmatism

This study adopts a pragmatic research approach. Pragmatism seeks to discover why specific situations appear as they do. The interpretation is limited by the specific situation, and pragmatism is thus strongly empirically founded in its study of phenomena (Egholm, 2014). The adoption of the pragmatic research approach should not be understood in the sense that the thesis tries to embrace everything that pragmatism represents. Instead, this study is based on the following pillars of pragmatism.

Firstly, pragmatism is rooted in a positive epistemological point of view. It implies that: "We assess a theory as true or false based on its practical consequences, not based on abstract principle" (Holm, 2018: 60). In other words, in the pragmatic notion of truth, something is true, when results are useful in practice and applicable in explaining phenomena. Furthermore, pragmatism allows drawing on theories from other philosophical stances as long as the theories in the specific situation and context explain the examined phenomena better than if the theories had not been applied (Egholm, 2014). However, the application of different theories cannot create inconsistency in the argumentation, and one must reassess the results if context changes or other theories explain the phenomenon better (Holm, 2018).

Secondly, in pragmatism, the nature of reality is understood as a flux of processes, experiences and practices. From a pragmatic view, phenomena are ever-evolving due to ongoing negotiations between social and individual. Therefore a pragmatic study often has an archaeological character, in the sense that it tries to analyse actions and relations of a specific context and the development of the phenomena (Egholm, 2014).

Thirdly, pragmatism is rooted in empiricism, and a theory's validity is assessed on its practical consequences when it is tested empirically (Holm, 2018). Even though empiricism is central in pragmatic research, it must be supported by existing theories to develop new knowledge about the phenomena. Thus theories can be applied based on how they can help explain the phenomena from the pragmatic notion of truth without taking into account everything they imply. According to Peirce (in Egholm, 2014), new knowledge is created when one's existing knowledge and habits are insufficient in explaining and

understanding new experience. For that reason, scientific research arises from something unexpected that cannot be explained with existing knowledge (Egholm, 2014). In this way, pragmatism employs an abductive approach.

The pragmatic approach founded in empiricism should be considered an operational choice which allows me to analyse and discuss the application of nudges to promote active transportation in Aarhus, including the experienced barriers and promoters from the perspective of the Mobility Team related in multiple levels of influence. Furthermore, the pragmatic approach is found relevant, as the concepts of nudging and choice architecture to a large extent, has emerged based on practice. What is at the focus in pragmatism and thus in this thesis is the practical end product of knowledge and how it enables people to act.

4.2 Research Design – A Case Study

In this section, I present my case study research design comprising the reason to use a case study, how I chose the case study of Aarhus and which type of case study it is.

4.2.1 Preliminary Research – Literature Review

The starting point of the research process was a personal desire to gain an understanding of the application of nudges to promote active transport in public policy. Therefore, I began my research process by conducting a literature review to be able to take part in and find gaps in the existing theoretical conversation. A detailed description of the literature review methodology can be found in Appendix 2. In the following, a summary of the literature review methodology is presented.

The literature review built the foundation of the further research process, as I learned that interventions are manifold, heterogeneous and often effective. Hereto several barriers to and promoters of active transport were identified. However, no overall pattern emerged, which is why I chose to conduct a case study to explore potential patterns of how nudges, barriers and promoters are interrelated in and influence active transport interventions.

4.2.2 Using a Case Study

The research design of this study is a single case study. Case studies are well suited to explain, describe or explore phenomena in their context. Yin (1994) defines a case study as an empirical inquiry that "investigates a contemporary phenomena within its real life context [...]" (Yin, 1994: 13) and argues that

case studies are helpful when "a how or why question is being asked about a contemporary set of events over which the investigator has little or no control" (p. 9). Thus, the case study enable an investigation of *how* nudges, and barriers and promoters are interrelated in and influence interventions to promote walking and cycling. Critics claim that a single case study is undesirable as research design, but Flyvbjerg (2006) and Eisenhardt (1989) argue that the strength of the case study is in its ability to create concrete, practical context-dependent knowledge and build theory. Thus, by exploring multiple data sources in an exploratory and descriptive manner, the case study has helped to understand nudging as a tool to change people's transport behaviour in a real-life situation. It has furthermore given an understanding of the complexity of the relatedness of numerous barriers and promoters that influence the implementation of such interventions.

4.2.3 Choosing the Case Study

As mentioned in section 4.2.1, the Danish part of the literature review presented contributions from the cities of Odense, Aarhus and Copenhagen. Therefore, I contacted the Mobility Departments of the three cities to clarify to what extent they use nudges and choice architecture to promote active transport and to request a possible case study cooperation. The Mobility Department of Copenhagen was too busy for a partnership. On the contrary, the feedback from Aarhus and Odense was positive. Both were interested in collaboration, and the empirical foundations seemed rich in regards to the use of nudges and choice architecture. Thus, I initially decided to include two case studies and did an in-person interview with Liv from Aarhus and Dea from Odense together with two of her colleagues. After the two first interviews, the thesis was put on hold for nine months due to maternity leave. When I returned, unfortunately, the COVID-19 lockdown challenged the continued data collection. The Mobility Department of Odense municipality was unable to set aside resources for further collaboration, and therefore I had to exclude the case of Odense. Luckily, Liv from the Mobility Team in Aarhus found time to do a second phoneinterview. Unfortunately, none of the two other members of the Mobility Team of Aarhus was able to do interviews. Despite the lack of additional interviews with the Mobility Team of Aarhus, the case still provided extensive data due to: the richness of the collected interviews with Liv, additional interviews with other nudge practitioners and secondary data. I decided that Aarhus Municipality would be a promising case study for exploring nudges as policy a tool to influence Aarhusians' active transport behaviour.

4.2.4 Type of Case Study

To achieve most valuable information from a single case in case-study research Flyvbjerg (2006) stresses that "cases are selected on the basis of expectations about their information content" (Flyvbjerg, 2006: 230). I perceive this case study to be an extreme case. In the perspective of Flyvbjerg (2006) "extreme cases often reveal more information because they activate more actors and more basic mechanisms in the situation studied" (Flyvbjerg, 2006: 229). Knowledge gained on active transport interventions in Odense and Copenhagen from the literature review and the in-person interview with the Mobility Team in Odense, revealed that the Mobility Team in Aarhus is working under other conditions. Firstly, the political support in favour of nudge and choice architecture application and active transport, in general, seems higher in Odense and Copenhagen appear to provide better conditions for using nudges and choice architecture to promote active transport compared to Aarhus. Thirdly, the Mobility Team in Aarhus is new to the use of nudges and choice architecture as a policy tool compared to traditional mobility procedures. Consequently, the case study of Aarhus presumably activates more basic mechanisms when promoting active transport.

4.3 Data Collection

The collection of data includes:

- Primary data: Two case-specific interviews and three interviews with nudge practitioners
- Secondary data: Case-specific data (websites, reports and folders brought into existence for the purpose of the Smart Mobility project and Cycle Superhighways project) and publicly available documents (grey papers, mobility plans, powerpoint presentations and online articles).

Multiple data sources were collected, as this thesis is based on an in-depth case study. The data collection was carried out over five months visiting Aarhus once excluding a nine-month break in between. The qualitative approach is chosen as a research method because it fits well to describe phenomena in its everyday context and enables a better understanding of the phenomena (Justesen & Mik-Meyer, 2012). A flow chart of the steps in the data collection process, including the preliminary research process, is presented in Figure 4.

Figure 4: Preliminary Research Process and Data Collection Process



4.3.1 Primary Data

4.3.1.1 Interviews

During the data collection process, I conducted five interviews in total. Two of these interviews were case-specific interviews with Liv, who was a part of the Smart Mobility project and works with active transportation in the Department of Urban Development and Mobility of Aarhus. The other three interviews included three nudge practitioners with general practical experience in applying behavioural insight to change public behaviour (see Table 6).

Following the pragmatic approach and abductive reasoning, the researcher creates connections between case, framework and theory in an iterative process to make informed decisions. To be as informed as possible, I decided to include expert interviews with nudge practitioners who all have practical experience

with behavioural public policy from public organisations or behavioural consultants applying nudge interventions for municipalities. As such, along with the theory applied, the expert interviews provide a vocabulary within nudging and choice architecture applications for the case. Expert interviews have, thus, been instrumental in connecting theory and case.

All interviews had a duration of 1-1.5 hour, dependent on the time the interviewees were able to dedicate and/or if a point of saturation was reached. All interviews were conducted in Danish, recorded and transcribed. Only quotes employed in this thesis have been translated into English.

Interviewee	Organisation	Role	Duration	Reference (I#=intervieu + number)	Appendix
		Case-specific interviews			
Liv Marie Stender Boisen	Department of Urban Development and Mobility	Anthropologist, focus on smart mobility and active transportation	1,5 hour* 0,5 hour	i1 i2	Appendix 3 Appendix 4
Gustav Friis	Department of Urban Development and Mobility	Urban design engineer, focus on mobility planning, and smart and green mobility	Absent from planned interview due to illness	-	-
Expert interviews					
Catrine Normann Jacobsen	Bro Communication	Behavioural consultant, focus on experimental design and evidence-based research. PhD in the field of behavioural- and experimental economics.	1 hour*	i3	Appendix 5
Ashley Brereton	Nudge By Brave	CEO and behavioural architect, focus on nudging and choice architecture in public schools, public and private workplaces.	1 hour	i4	Appendix 6
Thor Ridderhaugen	Metroselskabet & The Greater Copenhagen Light Rail	Project manager and behavioural advisor. Previously responsible for bicycle behaviour in the city of Copenhagen.	1 hour	i5	Appendix 7

Table 6: Overview of Interviewees

One case interview and one expert interview I carried out in person at the interviewees' workplace (marked with *). The remaining interviews were phone interviews.

4.3.1.1.1 Sampling and Sampling Size

This study comprises of five interviews that include four interviewees in total. Regarding the nature of the case study approach, no exact sampling size is agreed upon by qualitative methodologists, but they agree upon different factors that can affect the number of interviews needed to reach saturation (Roller &

Lavrakas, 2015; Kvale & Brinkman, 2015; Yin, 1994). Yin (2009) argues that "the typical criteria regarding sample size are irrelevant" when employing a case study approach and Creswell (2013) notes that the researcher should instead focus on getting various perspectives on the phenomenon being studied. Following Yin (2009) and Creswell (2013), this study sought to get as much information on different aspects of nudge and choice architecture interventions within the boundaries set by the COVID-19 lockdown rather than aiming for a certain 'golden' quantity.

The choice of interviewees was guided by purposive sampling. Purposive sampling is found in the premise that pursuing the best cases for the research study produces the best data (Patton, 2015). The better the interviewees are positioned to the phenomenom under study, the more information-rich the data will be (Patton, 2015). The case interviewee is an employee in the Department of Urban Development and Mobility of Aarhus. As a choice architect, Liv explicitly works with nudges and choice architecture in active transport interventions. Thus, Liv has ensured in-depth information and first-hand experiences on the nudge interventions carried out in Aarhus to promote active transportation. Another interview with Gustav Friis from the Mobility Team in Aarhus was planned, but the interview was cancelled because Gustav got ill.

Expert sampling is a type of purposeful sampling that is employed when knowledge within a particular form of expertise is required (Ilker, Abubakar, & Alkassim, 2016). The experts were deliberately chosen due to their practical experience within nudge interventions and choice architecture in public institutions. I identified the experts through the literature review.

4.3.1.1.2 Exceptional Circumstance - COVID-19 Lockdown

As already mentioned, the COVID-19 lockdown did not make it possible to hold additional in-person interviews nor did the situation allow the Mobility Team of Aarhus to prioritise telephone interviews further or contribute further to this thesis besides one follow-up interview with Liv. The follow-up interview with Liv enabled me to let her elaborate on and clarify statements from the first interview. Several other interviews were planned.

4.3.1.1.3 Interview methods

Semi-structured Interviews

The semi-structured approach was employed for all interviews. The flexible and in-depth nature of the semi-structured interview is suitable for this explorative case study. The semi-structured interview enables

both "[...] an exploratory approach that generates new knowledge and to stimulate interviewees' reflections on a number of pre-selected themes" (Justesen & Mik-Meyer, 2012: 53). If knowledge is obtained from specific questions only, it might leave the interviewer blind to other conditions essential to understand the phenomenon (Egholm, 2014). Thus, the semi-structured interview leaves room for what Kvale and Brinkmann (2015) call *deliberate naiveté* to put away presuppositions and gives the possibility to be open to new and unexpected perspectives of the phenomenon. With planned preliminary questions in the interview guide, types of nudges, barriers and promoters, and how they are related have been deduced by the statements, opinions and experiences the interviewees brought into play (Kvale & Brinkman, 2015).

Interview Guide

Two interview guides were compiled (Kvale & Brinkman, 2015): one tailored to the case-specific interviews with the Mobility Team, and one designed for the expert interviews. Common for the two interview guides was a deliberate use of *how* and *why* questions to encourage exploratory answers from the interviewees' interpretation of the active transportation initiatives (Eriksson & Kovalainen, 2008). Moreover, meaning clarification relevant to the study were conducted during the interviews to provide a better ground for the analysis (Kvale & Brinkman, 2015). The interview guides a4e found in Appendix 8 and 9.

4.3.1.1.4 Interview situation

The interview situation is an interaction between interviewer and interviewee which is why it is important to create a safe environment allowing interviewees to become 'active respondents' (Holstein & Gubrium, 1995) opening up about experiences and expressing opinions. The in-person interviews with Catrine and Liv took place at the interviewees' respective workplace to meet practical needs and create a comfortable interview setting. During the in-person interview with Liv, a trustful connection was created. This also benefitted the follow-up telephone interview with Liv who unfolded herself and entered into the responses like it was an in-person interview. To create a comfortable atmosphere during the telephone interviews, I included unformal chat in the briefing and debriefing of the interviews (Kvale & Brinkman, 2015). In general, I am under the impression that both Liv, Thor and Ashley felt confident expressing themselves during the telephone interviews. All interviews were conducted in Danish as interviewees either did not feel comfortable in the English language or felt they would lack the precision of expression in English.

4.3.2 Secondary Data

Secondary data is originally collected for other purposes (Saunders et al., 2006). This study employs secondary data that can be categorised into two main groups based on type and use. These are: case-specific data and generel empirical data. By critically evaluating secondary data sources and purposes in the context of their creation (Dahler-Larsen, 2008), secondary data has contributed to this study in various ways that will be elaborated in the following sections.

4.3.2.1 Case-specific Secondary Data

In connection with the in-person interview with Liv, I received the Smart Mobility project report covering the active transport interventions and evaluation, and the Aarhus Bicycle Action Plan 2017-2021 covering the Cycle Superhighways project. Case-specific secondary data also includes the Smart Mobility website created to inform and support the Smart Mobility project (Smart Mobilitet, n.d.) and a webpage about the Cycle Superhighways project on the website of Aarhus Municipality (Aarhus Kommune, 2019). The use and relevance of case-specific secondary data were fourfold: First, case-specific data has been used together with the primary data as part of the case (Bulmer et al., 2009) to provide additional information on the interventions carried out in Aarhus to promote active transport. Secondly, the case-specific data enacted to evaluate whether the case interviewee's statements correlated with their actual actions and opposite. As such, secondary data constituted a potential for triangulation (Denzin, 2012). Thirdly, gaps in the storyline told by the case interviewee were filled with the help of case-specific secondary data. Finally, the Smart Mobility report is composed of both Liv, Gustav and Charlotte (the Smart Mobility Team) and so, the report contributed with additional voices and perspectives to the study.

4.3.2.2 General Empirical Data

Several sources of secondary data have served as background information to gain knowledge of the field from which this study origins. The *Mobility Plan Aarhus City* formulated in 2018 and covering mobility action plans towards 2050 (Aarhus Kommune, 2018) contributed to a better contextual understanding of active transport promotion in Aarhus. PowerPoint presentations from the Danish National Cycling Conference 2018 (Den Nationale Cykelkonference, 2018) have been used in the preliminary research phase to gain background knowledge on the use of nudges and choice architecture to promote bicycling and walking in Danish cities. Additionally, sources of secondary data have contributed to general empirical data besides serving as background information to build more robust interview guides.

Furthermore, together with the primary data, general empirical data, scientific articles and grey papers collected in the literature review research process have following the abductive approach formed the basis for the research questions.

4.3.3 Limitations to Data

I identify the following limitations to data: representativity, lack of observation, the time of the data collection and context-independent interview. The limitations are presented in detail below.

Representativity

The focal actors of this study are the choice architects – more specifically, the Mobility Team of Aarhus Municipality. The Mobility Team consists of three employees of whom only Liv is represented in the primary data, which might be a limitation to data. She alone cannot necessarily represent the multi-faceted experiences and views of the team. However, Liv is central to the application of nudges and choice architecture to promote active transport due to her position and background compared to the others. Furthermore, I have tried to counter this potential limitation to data by including secondary data produced among others by Gustav and Charlotte, hence representing their voices.

Lack of Observation

My primary data is solely based on interviews. However, I see potential in observation as a supplementary method as it would have been interesting to observe a phenomenon in its context (Silverman, 2001). By the use of observation, I would also be able to identify what may be left unsaid. As such, observation would have been a direct access to identify other potential barriers and promoters and how they are related to the nudges from a multi-level perspective. However, as my findings suggest I have still been able to structure an overall pattern based on the rich data in my interviews.

The Time of Data Collection

The Smart Mobility project was carried out between 2014 and 2018, and the Cycle Superhighways were built between 2016 and 2019. The information gathered from Liv is to some extent, based on the retrospective memories and might be prone to bias. To overcome this potential limitation to data, I crosschecked case interviews with the case-specific secondary data. Liv explained how learnings, practices and experiences from the Smart Mobility project are carried over in the development of new projects (i1), which suggests that the memory of Liv has not become biased over time. Despite that the time of entry is a limitation to data, the data has proven to comprise valuable rich data.
Context Independent Interviews

The inclusion of expert interviews constitutes a limitation to data. The experts' statements are based on practical experiences with nudging and choice architecture from contexts different from the context of the active transport promotional work in Aarhus. The expert interviewees work in consultancies or public organisations. Throughout the data analysis, I have been aware of this limitation and only employed statements from expert interviews to address how different levels of barriers and promoters influence the application of nudges in active transport interventions.

4.4 Data Analysis

This section presents the overall approach to analysing the data leading to the findings. The data analysis process was empirically-driven and characterised by continuous cycles of making analytic sense of the data by means of memo-writing, coding and investigating the existing theoretical landscape through an abductive approach. The data analysis process consists of following, to some extent, overlapping phases of memo-writing, predetermined coding, open coding and axial coding. The phases are elaborated in the following. To conclude, I shortly mirror the data analysis process against the abductive approach.

4.4.1 Memo-riting

Bryant (2017) stresses how memo-writing "prompts researchers to analyse their data and develop their codes into categories early in the research process". I started writing memos after the first interview with Liv forming ideas and thoughts. I continuously wrote memos as I carried out and transcribed the additional interviews. As the complexity of the case increased, more clear interpretations of nudges and barriers and promoters and how they are related emerged. As such, memo-writing has been a valuable tool to form the story-line of the study (Birks, Chapman, & Francis, 2008). During the memo-writing, I found out that most of the interventions were designed around various choice nudges and architecture changes. It also surprised me that Liv put more emphasis on the barriers and promoters to active transport interventions than to the effect of the interventions. This realisation contributed to interpret the data against the social-ecological model.

4.4.2 Pre-determined Coding and Nudges and Choice Architecture

All interviews were transcribed and coded. Based on the identification of various types of nudges and choice architecture designs during the memo-writing I decided to code the data with pre-determined categories. This decision was further reinforced by the fact that "nudges span an exceedingly wide range, and their number and variety are constantly growing" (Sunstein, 2014: 3). I found Sunstein's (2014) list

of ten important nudges to be an appropriate fit to explore the use of nudges and choice architecture to promote active transport. In the coding process of the case-specific data, whenever I came across a change in the social or physical environment, I labelled the code with words or a short phrase describing the nudge (e.g. 'borrow a folding bicycle and test combination travel') before placing it in one of the ten nudge categories (e.g. 'increases in ease and convenience'). For each code, I noted which intervention it related to (e.g. 'Super Commuters'). As a help in this process, I created a table describing all identified active transport interventions and included codes and categories (Appendix 1).

A disadvantage of pre-determined coding categories is the risk of missing some findings (Crabtree & Miller, 1999). To overcome the risk of overlooking other types of nudges than the ten proposed by Sunstein (2014), I stayed open to the data. I named an 11th category *Other* for the codes that did not fit into the pre-determined categories. The 11th category was later labelled 'built environment' because all codes described infrastructure or some sort of physical change to the environment (e.g. 'a combination travel terminal', 'cycle bridges and tunnels').

Not all types of the ten nudges presented by Sunstein (2014) were identified in the data and are therefore not included in the findings. The final codes of nudge applications are shown in Figure 5.



Figure 5: Final Nudge Codes

4.4.3 Open Coding – Barriers and Promoters

From the realisations made through memo-writing, I engaged in open coding on the case interviews to identify barriers and promoters to the implementation of active transport interventions. Open coding is described by Corbin & Strauss (1990) as "(...) the interpretive process by which data are broken down analytically" (p. 10) with the purpose of gaining new insights. The method of open coding was chosen to assure the credibility of the interviewee and avoid biasing her responses (Corbin & Strauss, 1990). I started by reading the interview transcription several times. Then I identified and labelled "meaning units" (Côte, Salmela, Baria, & Russell, 1993), describing factors or incidents that seemed to have challenged or eased the attempt to implement active transport interventions. This process of reading the transcription and labelling meaning units was repeated until I did not find any new meaning units. I then compared meaning units for similarities and differences and grouped units with common features (Côte et al., 1993).

All the codes related to barriers were grouped into 14 categories. The 14 categories were then reduced to six overall categories. The codes concerned with the promoters of active transport were grouped in 11 categories and after that reduced to five categories. The final codes of barriers and promoters are presented in Figure 6 and Figure 7.



Figure 6: Codes of Barriers



Figure 7: Codes of Promoters

I included expert interviews to get a better understanding of barriers and promoters of active transport interventions from the perspective of choice architects. I coded the expert interviews separately from the case interviews using the identified codes of barriers and promoters. The barriers and promoters experienced by the choice architects are case-specific and context-dependent of the specific context of active transport in Aarhus Municipality. As such, the expert interviews do not constitute the case but act as a tool to understand and explore the findings.

4.4.4 Axial Coding - Relations Between Nudges and Barriers and Promoters

To integrate codes of nudges, barriers and promoters, I started diagram- and memo-writing following the main principles of axial coding. Each intervention functioned as a frame from which I tried to explore the context of the nudges, barriers and promoters and their relations (Kelle, 2005). Axial coding is developed by Strauss and Corbin (in Kelle, 2005) who refer to the approach as a general model rooted in pragmatist and interactionist theory to build a frame for the developing concepts and categories and their relationships.

I simply used paper and pen to draw diagrams trying to link barriers, promoters, nudges and explanations together. This approach allowed me to explore paths of analysis as ideas were constantly reshaped, expanded and replaced. In this process, relations started to emerge. I discovered that each intervention was influenced by various types of barriers and promoters at different stages and that the applied nudges

also worked at some of these stages in the attempt to change active transport behaviour. Furthermore, what constituted a barrier for one intervention could be a promoter for another. I also saw that barriers and promoters within interventions are related to and influence one another. At this point I had not yet found a vocabulary to communicate the findings. I reviewed literature within social theory in search for a multi-level perspective on interventions to promote active transport. Within social theory I found different models of social ecology inspired by Urie Bronfenbrenner (1979). I found that the approach of Sallis et al. (2006) expressed my findings well, but allowed to combine it with the conceptual framework proposed by Larouche & Ghekiere's (2018) as the latter includes five levels of influences (the individual, interpersonal, community, built environment and policy level) conceptualised specifically to active transport behaviour. I found that the social-ecological model was a good match to encompass the multi-level complexity of active transport promotion in Aarhus.

4.4.1 Abduction

In line with the philosophical stance of pragmatism, the data analysis method of this study mirrors abduction. The abductive work process begins with an empirical surprise which leads to the formulation of hypotheses which are tested through existing theories and methods to come up with qualified guesses to explain why the situated reality appears the way it does (Holm, 2018). To be able to take part in the theoretical conversation, this study was initiated by a literature review. As such, I was, to a certain extent, informed in the theoretical and empirical field of nudges and choice architecture application to promote active transport in Denmark. From here on, I initiated my case study and the iterative process of moving back and forth between the empirical data and existing theories through the phases of data analysis explained above. Based on this process, I managed to form my conceptual framework that combines types of nudges, experiences of barriers and promoters and the social-ecological model. As such, I have formed a theoretically rooted explanation for the phenomena observed in the empirical data (Burks, 1946). In line with abductive reasoning, this study has shown that discovery "depends on the inability to frame findings in existing theoretical frameworks as well as on the ability to modify and extend existing theories in novel ways" (Timmermans & Tavory, 2012: 173).

4.5 Quality of the Study

Criteria for evaluating the quality of qualitative studies vary among researchers. Traditional quality criteria used in research, e.g. internal validity, generalizability, reliability, and objectivity, are found unsuitable for qualitative research (Korstjens & Moser, 2018). Qualitative researchers speak of trustworthiness. Hence quality rests in the trustworthiness of the study and its findings (Guba & Lincoln,

1985). Alternative approaches to quality assessment are manifold (Kvale & Brinkman, 2015; Korstjens & Moser, 2018; Justesen & Mik-Meyer, 2012). I employ five quality criteria of trustworthiness presented by Korstjens & Moser (2018) covering *credibility, transferability, dependability, confirmability* and *reflexivity*. In the following I explain how the five criteria are relevant to this study.

Credibility

Refers to the 'truth' in the findings in terms of representing plausible information and correct interpretation from the participants' perspective and views (Korstjens & Moser, 2018). To ensure credibility, I practised triangulation of data and methods. Triangulation has both served as a way to cross-check data and to understand the application of nudges and choice architecture to promote active transport in Aarhus from various views to ensure credible data.

Transferability

The transferability criteria concern the degree to which findings have applicability in other contexts (Korstjens & Moser, 2018). This study disassociates from knowledge as being context-free or formally generalisable. However, I believe that other cases of behavioural insights to promote active transport experience some of the same barriers and promoters as I present in the findings. By providing 'thick descriptions,' I enable what is called *transferability judgement* (Korstjens & Moser, 2018). By providing thick descriptions of the active transport interventions, the interaction of nudges and experienced barriers and promoters besides the context of active transport interventions in Aarhus Municipality, I enable readers to assess if the findings of this study are transferable to their context.

Dependability

Consistency is the root of the quality criteria of dependability, and as such, the process of analysis must be in line with standards of given research design (Korstjens & Moser, 2018). In this thesis, I believe I have provided transparency of the research process by describing the research steps from the preliminary inquiry to the data collection process and development and reporting of findings. Moreover, I have consciously highlighted *when*, *how* and *why* my approach deviates from the overall rules of thumb within the chosen research design. Besides the research design, I have also tried to conform to the cornerstones of pragmatism.

Confirmability

Confirmability concerns the aspect of neutrality and thus to the extent to which research findings can be confirmed by other researchers (Korstjens & Moser, 2018). In line with the dependability criteria, I sought

to describe my process of analysis thoroughly to make it as transparent as possible to other researchers. Furthermore, I have tried my best to put my thoughts and perspectives in parentheses in the interpretation process.

Reflexivity

The criteria of reflexivity are the process of critical self-reflection (Korstjens & Moser, 2018). Throughout the process of analysis, theories have continuously been reevaluated to explain the phenomena seen in the data (Holm, 2018). Moreover, the iterative approach has assured that I systematically have attended to and reflected upon the context of knowledge construction.

5. Findings

The findings are structured into three parts. The first part presents the identified nudges for each active transport intervention The second part dives into the various barriers and promoters experienced by the choice architects, and the third part illustrates the relations of nudges and barriers and promoters by the use of the social-ecological model.

5.1 Findings Part 1 – Interventions and Nudges

This section explains the identified nudges applied in the 11 active transport interventions in Aarhus by the Mobility Team. The interventions were part of the Smart Mobility project except for one, the Cycle Superhighways, which is a result of the Aarhus Bicycle Action Plan. The intervention design and types of nudge applications of the three interventions 365 Days By Bike, In Tailwind and Headwind and Super Commuters are similar and therefore presented together. The Park and Bike Terminals are located in connection with the Cycle Superhighways. Therefore the findings of these two interventions are combined.

5.1.1 365 Days By Bike (1), In Tailwind and Headwind (2) and Super Commuters (3)

In the interventions 365 Days By Bike, In Tailwind and Headwind and Super Commuters participants consisted of motivated citizens in Beder-Malling, a suburb to Aarhus, who pre-committed to commute by bike for 12, six and four months, respectively (Smart Mobilitet, 2018). The Super Commuters intervention differed from the two other interventions, in that participants were given a folding bicycle, instead of electric bicycles, and tested mixed-mode travel combining bicycling with bus or train.

One of the nudges applied in the three interventions is pre-commitment which exploits that when people commit to a specific course of action, they are more likely to act in accordance with their committed goal (Sunstein, 2014). Registering for a project and setting up competitions between participants, sought to motivate participants to choose the electric bicycle or the folding bicycle in combination with public transport and leave the car at home. As regards 365 Days By Bike, the pre-commitment nudge was reinforced through individual health goals and health measurements every second month (Smart Mobilitet, 2018).

The three interventions also nudged participants by framing choices in terms of increases in ease and convenience. Resistance to change behaviour is often based on perceived difficulty (Sunstein, 2014). Concerning the two electric bicycle interventions, Liv states that access to an electric bicycle to a certain

extent changed the perception of distance for commuters to bike: "Participants told us that they would never travel the distance between their home and work-place on a regular bike. For them it was either electric bicycle or car" (i1). By lending participants an electric bicycle and providing bicycle maintenance, the Mobility Team sought to change the choice default, thus removing the perception of transporting by bike as unfeasible and impractical: "We experienced participating families with children that commuted 45 km on electric bicycles each day" (i1). In both interventions, a large share of the participants bought the electric bike post-intervention (i1). In Super Commuters the increases in ease and convenience nudge was applied in that participants were given a folding bicycle and a bus or train pass to let participants test the folding bike on daily commutes and assess the feasibility of combination travel before investing in a folding bike (Smart Mobilitet, 2018).

Another nudge employed in the 365 Days By Bike, In Tailwind and Headwind and Super Commuters interventions, is eliciting implementation intentions. People are more likely to commute by active modes of transport if their implementation intentions are elicited (Sunstein, 2014). The Mobility Team only recruited motivated participants (i1) and as such had an intention that could be triggered: "The interventions [ed. 365 Days By Bike, In Tailwind and Headwind and Super Commuters.] were mostly successful for [people] [...] with a desire for a lifestyle change" (i2). In addition, it was seen that the nudge had most substantial effect on people without younger children. Liv explains: "These couples had the time to support each other and time to spend ten extra minutes on transport" (i2). It appears that the aspect of available time and support influence the ability to evoke intentions to change.

The uses of social norms nudge were also applied in the three interventions by designing the interventions to utilize people's tendency to 'follow the herd' (Thaler & Sunstein, 2008; Thaler R. H., 2015). The social environment was shaped by the actions of the participants to influence neighbouring people to copy the behaviour: "At some point, we had three habit-breaking projects at the same time in Beder-Malling. Participants biked around on folding bicycles and electric bicycles and wore jackets with logos" (i1). Liv further elaborates:

"We gave participants bright coloured jackets for them to stand out and be noticed. They communicated about the interventions in the areas they moved in by bike. [...] It creates a lot of awareness in the communities. When they tell their neighbours that they feel less stressed and have a better experience with letting off work stress before coming home, the neighbours feel like buying an electric bike too" (i1).

Altogether, the participants were employed as 'active transportation ambassadors' (i1) intended to send positive signals to non-participants about the ability to travel by bicycle when living in the suburbs around Aarhus.

Finally, as regards 365 Days By Bike, a 'tracking app' counted the participants' trips providing feedback on bicycling behaviour (Smart Mobilitet, 2018). Making information visible to participants is an example of the nudge warnings, graphics or otherwise.

5.1.2 Walking School Bus (4)

The Walking School Bus intervention was an offer to students from grade 0-5 at four schools at four schools (two in Beder-Malling). The students could 'get on' the Walking School bus and be chaperoned by older students along a fixed route with four to five stops.

The Walking School Bus applied the increases in ease and convenience nudge targeting parents. By creating a choice context with safe self-transport and traffic education, parental resistance towards self-transport was sought reduced. Moreover, the parents were also presented with the opportunity to: "[...] have a more flexible morning. They have the possibility to travel at another time in the morning or use another mode of transport to work" (Smart Mobilitet, 2018: 34) thereby framing the Walking School bus as a convenient, safe and responsible choice. Walking School Bus is an attempt to alter the choice default, thus trying to steer parents in the direction of supporting their children in safe active self-transport to school.

Other nudge applications include warnings, graphics or otherwise, which triggers people's attention and may increase the probability that people will pay attention in the long run (Sunstein, 2014). The walking bus stops were marked with signs where the students met and waited for the bus (see picture, Smart Mobilitet, 2018).



The intervention also sought to nudge through the uses of social norms as a group of students walking together in

reflective vests are drawing attention in the landscape potentially inspiring other students to join (i1; Smart Mobilitet, 2018). The fact that older students chaperoned the walking bus can also act as social influence because younger students often look up to the older ones or as the Smart Mobility project report puts it: "The Walking School Bus strengthens fellowship across year groups" (Smart Mobilitet, 2018: 34).

5.1.3 The Traffic Snake Game (5)

Students in grade 0-3 from four schools in Aarhus (two in Beder-Malling) participated in the two-week European travel to school campaign, The Traffic Snake Game, that focuses on sustainable modes of transport, including bicycling and walking (Smart Mobilitet, 2018). Three types of nudge applications were identified.

The use of the warnings, graphics or otherwise nudge was applied in that students received visual feedback on class progress through stickers on a snake poster. The students could also compare themselves to the progress of the other classes. The visual information intended to send a positive message to students associating active transport choices with the notion of the 'right' behaviour. Moreover, presenting travel

behaviour vivid and salient – like the snake poster (see picture, Smart Mobilitet, 2018: 61) – is likely to have a more significant impact on people's behaviour than information that is statistical and abstract (Sunstein, 2013).

In The Traffic Snake Game "a collective goal is made at the class level on how many car trips to be converted into sustainable trips" (Smart Mobilitet, 2018: 60). Classes



competed against each other and were rewarded with prices when reaching goals (i1). Setting goals and organizing competitions attempt to influence students to choose active modes of transport in an eagerness to win prices and is in this way a nudge by the use of pre-commitment strategies.

Finally, the same way as in the Walking School Bus intervention, The Traffic Snake Game also tried to nudge through the uses of social norms by utilizing students' tendency to be impacted by and hence copy the behaviour of their peers.

5.1.4 Visible Electric Bicycles (6)

In the Visible Electric Bicycles intervention, electric bikes were introduced and located in the entrance hall of the workplace in the Department of Urban Development, Construction and Environment as an alternative to company cars for transport during working hours (Smart Mobilitet, 2018). According to Thaler and Sunstein (2008), people often make the easy choice. The placement of the electric bicycles entailed that employees walked right 'into' them when leaving for an errand (1i) which sought to encourage employees to, intuitively, choose an electric bike instead of a company car simply because the option was the 'easy' choice. The applied increases in ease and convenience nudge targeted environment accessibility and awareness (Sunstein, 2014).

5.1.5 City Bike Trailers (7)

City Bike Trailers were free to pick up from city bike dock stations, located in Aarhus city, and return after use. The trailer was rented as required, compatible with Aarhus City Bikes (bicycle sharing system) and own bicycles, and not associated with concerns about maintenance or storage. The City Bike Trailers constitute a change in the choice context sought to reduce potential barriers possibly preventing Aarhusians from engaging in bicycling for the transport of big items, as resistance to change is often a result of difficulty (Sunstein, 2014). As such, it is an example of the increases in ease and convenience nudge. Moreover, the City Bike Trailers were "foiled with the Smart Mobility posters on wheels, sides and bottom of the trailer" (Smart Mobilitet, 2018: 12) aiming to catch the eye and create awareness among Aarhusians thereby encouraging active transport through the warnings, graphics or otherwise nudge.

5.1.6 Bicycle Library (8)

The mobile Bicycle Library enabled Aarhusians to borrow different sorts of speciality bikes (e.g. electric, cargo and lightweight bicycles) for up to seven days as a way to test speciality bikes. Liv explains the reason for the intervention:

"An electric bicycle is a heavy investment – it costs around DKK 20-25,000 – if you do not know if it works. You know a car works, and if you buy one for DKK 50,000, you can be sure that you can get to work. So it is about being able to test the bicycle on the daily trips and experience whether it is feasible. Before investing, one must be assured it works smoothly" (i1).

The increases in ease and convenience nudge enabled Aarhusians to borrow and test a speciality bike for free, thereby seeking to "[...] break down possible barriers related to give the bike a try for everyday trips" Smart Mobilitet, 2018: 16) with the hope that the electric bicycle turned out to be a more attractive alternative than the car.

In addition, the warnings, graphic or otherwise nudge was applied through large-scale signs promoting the Bicycle Library, e.g. in a car park in Aarhus midtown (Smart Mobilitet, 2018).

5.1.7 Get Cycling (9)

Aarhus was part of the partnership campaign Get Cycling that motivated Aarhusians to choose the bicycle on short trips (< 5km) through a cycle coach app combining automatic tracking with targeted coaching and local events (Smart Mobilitet, 2018).

The cycle coach app combined two nudge applications – warnings, graphics or otherwise and pre-commitment strategies.

The app sought to utilize that consistent behaviour is best achieved by commitment strategies (Sunstein, 2014). Participants set up a profile with personal goals and received targeted coaching through the app trying to encourage participants to commit to their goals. The app gave participants



feedback on bike performance and sent positive messages when a personal goal was achieved (Smart Mobilitet, 2018). As such, the Get Cycling intervention tried to nudge Aarhusians to choose the bicycle for short trips by rewarding 'positive' behaviour – bicycle behaviour.

Furthermore, the campaign also employed the warnings, graphics or otherwise nudge through visual awareness, e.g. road signs stating: 'Take the bicycle and fill the piggy bank' (Ta' Cyklen Danmark, n.d.) as well as having flowers painted on the bicycle symbols on the pavement (i1).

Information emphasising that many people wish to engage in a particular type of behaviour can be a very powerful nudge (Sunstein, 2014). The Get Cycling intervention employed messages about social norms on print-based adverts and posters such as 'More than one-third of Danish drivers want to bicycle more in the future' (Ta' Cyklen Danmark, n.d.) thereby trying to nudge Aarhusians in the direction of doing what most people do (uses of social norms), hence choosing the bicycle for short trips.

5.1.8 Park and Bike Terminal (10) & Cycle Superhighways (11)

The Cycle Superhighways are part of a project to construct a coherent cycling route network in Aarhus. Providing bicycle infrastructure is a change in the physical environment, guided by behavioural insights. Hence the built environment and the physical attributes of the built environment try to nudge Aarhusian commuters, who would otherwise drive by car, to bicycle to their final destination.

The suburban segments include cycle bridges and tunnels, serpentine shaped paths on steep slopes, smoothening of differences in terrain, wide paths, nature experience, e.g. strawberry fields, and LED guiding lights in the pavement (Aarhus Kommune, 2017; i1). These design features, hence built environment nudges, seek to provide safe and passable routes for bicycling that give commuters the perception of bicycling as an attractive mode of transport.

The inner-city segments of the Cycle Superhighways include street-level attributes such as 'green waves' (cyclists can surf a wave of green lights during rush hour), bicycle streets, cycle and pedestrian street boards, guiding cycle symbols on the pavement, road trees separating cars from bicycles, narrow roadways, speed bumps and elevated surfaces (i1: Aarhus Kommune, 2019). These changes in the physical environment seek to favour bicycles in terms of increased safety, accessibility and passability hence convincing Aarhusian commuters that it is worthwhile to commute by bike.

Moreover, service stations and cycling barometers (registering and displaying today's and the total number of passing cyclists) located along the cycle superhighways (Aarhus Kommune, 2017; i1) aim to increase the perception of the bike as being a reliable mode of transport and signal to Aarhusian cyclist that their active transport behaviour matters. The latter is also an example of the warnings, graphic or otherwise nudge.

The Cycle Superhighways run near Aarhus light trail (Letbanen, Danish) and the rural parts pass the two Park & Bike terminals enabling combination travel. The Park and Bike Terminals attempt to make it easy to combine bicycle commuting with public transport or car (Aarhus Kommune, 2017): "They [ed. The Park and Bike Terminals] are established in connection with Aarhus light rail. It allows you to shift to the light rail from car or bicycle; a multi-change zone. It is close to the highway" (i2). Besides ensuring connectivity, the terminals were designed to support the targeted behaviour: "My colleague Charlotte has been very concerned about [...] logical leading lines and optimal conditions for bike parking" (i2)

The Mobility Team is in the process of improving the communication and signage on the Cycle Superhighways to nudge the way cyclists behave, improve wayfinding and reduce the speed of commuters when they reach the city zone. Liv emphasises how the Mobility Team follow best practice: "We are in the process of making signage similar to those on Copenhagen Cycle Superhighways: orange print and angular shape with the route number. We reuse them because evaluation has shown they work well" (i1). Moreover, Liv gives an example of a message on the pavement to nudge people to reduce speed: "slow down – you are biking in a city with mixed traffic" (i2).

5.2 Sub Conclusion Part 1

The findings show that all interventions combined up to five types of nudges, except for the Visible Electric Bicycles intervention where only one type of nudge was identified. Moreover, resemblances were found across interventions in terms of types of nudges. The bicycle interventions in Beder-Malling (1-3) applied the same types of nudges, the two active school transport interventions (4-5) show similarities of

type of nudge applications and so does the bicycle lending interventions (7-8) and the two interventions applying built environment nudges (10-11).

The Mobility Team has to a great extent attempted to nudge Aarhusians by increases in ease and convenience in connection with bicycling, making information visible and providing different types of feedback on active transport behaviour through warnings, graphics or otherwise. Furthermore, the Mobility Team nudged by utilizing social norms and ensuring pre-commitment to active transport behaviour through goal setting and competitions. Through changes in the built environment, the Mobility Team attempted to provide safe, passable and accessible bicycling and walking infrastructure connecting Aarhusian commuters with their final destination and allowing for combination travel.

The combination of types of nudges sought to create a choice architecture that reduces Aarhusians perceptions of difficulty or possible barriers to engaging in active transport besides designing a choice context in which the bicycle is the easy and convenient choice, hence appears more attractive than the car. An overview of the nudge applications is provided in Table 7.

Intervention	Types of nudge		
365 Days By Bike (1)	 Use of social norms Increase in ease and convenience Pre-commitment strategies Eliciting implementation intentions Warnings, graphics or otherwise 		
In Tailwind and Headwind (2)	 Use of social norms Increase in ease and convenience Pre-commitment strategies Eliciting implementation intentions 		
Super Commuters (3)	 Use of social norms Increase in ease and convenience Pre-commitment strategies Eliciting implementation intentions 		
Walking School Bus (4)	Use of social norms Warnings, graphics or otherwise Increase in ease and convenience		
The Traffic Snake Game (5)	 Use of social norms Warnings, graphics or otherwise Pre-commitment strategies 		
Visible Electric Bicycles (6)	Increase in ease and convenience		
City Bike Trailers (7)	 Increase in ease and convenience Warnings, graphics or otherwise 		
Bicycle Library (8)	 Increase in ease and convenience Warnings, graphics or otherwise 		
Get Cycling (9)	 Use of social norms Warnings, graphics or otherwise Pre-commitment strategies 		
Park and Bike Terminal (10)	 Increase in ease and convenience Warnings, graphics or otherwise Built environment 		
Cycle Superhighways (11)	Increase in ease and convenience Warnings, graphics or otherwise Built environment		

Table 7: Types of Nudges

5.2 Findings Part 2 – Barriers and Promoters

This section presents the barriers and promoters that the Mobility Team experiences while implementing the nudges in the interventions.

5.2.1 Barriers

Political Focus

The Mobility Team encounters the fact that the political focus of Aarhus Municipality is a barrier to implementing transport interventions. Liv explains that: "it is a political decision how much space the individual mode of transport gets. At the moment, it is more difficult to find space for bicycles and pedestrians [...] because focus from the political side is on growth and extending car capacity. They want to ensure good possibilities to get to the city" (i1). The department of Urban Development and Mobility must support the overall political visions of Aarhus Municipality. As the political party in charge changes, so does some of the requirements that The Mobility Team work under: "we are very vulnerable to the fact that we are continually changing political leader. It makes a huge difference whether you are working under a councillor, who pays a lot of attention to urban life and reducing congestion, or one who wants a lot of parking and new lanes on the highway" (i1). Furthermore, the Mobility Team finds it challenging that they continuously have to change the content and focus of the mobility plans, from which the active transport interventions stem because they depend on the current political direction (i1). According to Liv, the Mobility Team is currently adjusting their mobility plans at the expense of active modes of transport and in favour of cars: "Now we must prioritise parking space for everyone. With the prior councilman, parking spaces were removed, and it created increased urban life, and we could use the streets for other purposes than cars" (i1).

The working procedures in Aarhus Municipality are also found to be challenging for nudge applications as the road from idea to implementation is long. Consequently, most interventions were small scale. Liv elaborates on this matter: "It is hard to make big things happen within the life span of an innovation project in this big 'company'. It is a long-term process to have the project passed. That is one of the reasons why we worked in small scale projects" (i1).

The department of Urban Development and Mobility has many interfaces with the other magistrate units in Aarhus Municipality. Still, no tradition or time is allocated for collaboration across departments in the magistrate. Liv stresses: "We need someone from the top to give their consent that we can spend time and resources to enter into cooperation across departments. That I [ed. Liv] is part of a health committee because managers acknowledge that active transport is a lever in the health agenda and vice versa" (i1). But the political agendas across departments and magistrate units vary in Aarhus Municipality which Liv finds hampering to the interventions: "It is a considerable challenge. That is the reality in a politically driven organisation. We try to network and create subgroups, but it is not permanent because of constant restructuring. In that process, much of the cross-sectional work dissolves" (i1).

Lack of Resources

Allocation of resources is a significant barrier to the possibility of launching active transport interventions at a large scale in Aarhus. Liv clarifies: "The biggest challenge from my perspective is the lack of prioritisation of resources to do this on a big scale. The Smart Mobility project includes micro-projects in a huge city like Aarhus. It takes work force to roll it out. We do not have those resources now" (i1). The Mobility Team carried out interventions to gain experience with nudge applications, test if they had the desired impact on Aarhusians' active transport behaviour and assess the up-scale potential. However, Liv stresses that the Mobility Team's ability to up-scale the promising interventions depends on political prioritisation:

"They [ed. the interventions] are, among other things, ranked according to how easy they are to upscale. But it still depends on somebody giving their consent to spend money on, for instance, working with electric bicycling in every suburb around Aarhus. Nobody has given their consent yet. This way, things like this can take a long time" (i1).

The nudge practitioners all highlight the importance of consent from decision authorities (i5, i3). Catrine points out: "You need the right people to say 'yes' to what needs to change. Otherwise, you get nowhere" (i3).

Moreover, the money allocated to the Department of Urban Development and Mobility is primarily prioritised to the strategic planning of the infrastructure of the roads and not actual transport behaviour. Liv says: "It is a challenge to work in a field where you do not have the resources to create lasting behavioural changes. It requires research to target solutions and bicycling infrastructure. It requires tremendous amounts of money" (i1). She continues "in the projects in Beder-Malling it was resource-demanding to recruit, communicate and interview participants in the intervention besides coordinate health measures and press relations" (i1). Catrine addresses this barrier: "There is a difference between working with choice architecture with a theoretical and scientific objective compared to in practice. One reason is that it is too expensive in man-hours" (i3). Furthermore, the Mobility Team also finds it problematic that resources do not suffice the repetition of interventions. Catrine describes this temporal

importance of interventions in connection with lasting behavioural changes: "it is important to continuously focus on transport habits because the behavioural effect is reduced over time" (i3).

The Mobility Team also experiences that interventions to promote active school transport are impacted by lack of economic means to ensure safe pedestrian and bicycle infrastructure: "If we [ed. the Mobility Team] offers to help primary schools communicate active transport. They answer that they will not collaborate before we have built a bicycle path" (i1). Liv further explains that many school collaborations break down because the Mobility Team cannot find the finances to make the necessary changes in the built environment around schools, but also due to lack of resources within the individual schools: "It is tough. If we do not anchor the interventions at the schools, if they say that they have few resources, it is my opinion, that we are facing great difficulties implementing the interventions constructively" (i1). The Mobility Team generally experiences that "there are limited resources and ownership to campaigns at schools" (Smart Mobilitet, 2018: 61).

Legislation and Permissions

Rules and legislation were found to constitute a barrier for the Mobility Team in terms of making changes in the physical environment. Liv describes it in this way: "There are many and strict rules about what is allowed to communicate in an urban space because road safety is of highest priority and if there is too much information it will confuse the road users" (i1). The Mobility Team must apply for permission to put up signage and communication on signs and the pavement. As an example, during the Get Cycling campaign, the Mobility Team wanted to paint flowers on the bicycle pavement symbols in the inner city. They got temporary permission but only with paint that can be rained out. Liv explicates the issue: "(...) if you use that, the lines are often gone before people have seen it" (i1). Liv further elaborates legislative challenges faced by the Mobility Team: "We wanted to try many things that were not possible due to legislative rules. When we first started the Smart Mobility project, we did not know how Aarhus Municipality, the traffic police or the Danish Road Directorate work" (i1). In continuation, the Mobility Team found it challenging to obtain permissions from both the Department of Children and Young People and the individual primary schools to carry out school traffic habit surveys in Aarhus (Smart Mobilitet, 2018). The Mobility Team also experiences stringent requirements to which type of information and communication they are allowed to send to citizens through e-Boks. It constitutes a barrier to the nudge applications since the Mobility Team experiences that people do not read anything that comes in through the letterbox while, especially young people, do not check their e-Boks (i1).

The Danish School Reform was also found to work as a barrier to the implementation of active school transport interventions. "The schools are challenged by their obligation to the school reform. They have a to-do list, and transport is at the bottom of the priority list even though they are aware that traffic congestion outside schools in the morning poses dangerous risks to students" (i2). Road safety classes are mandatory in Danish primary schools, but are not assigned lessons and rarely integrated into the school's yearly plan which makes it hard for the Mobility Team to anchor projects at schools (i2): "The challenges are to a large extent to convince schools that they can gain something from the walking school bus. As such, it has been difficult to receive the necessary prioritising and resources at the schools" (Smart Mobilitet, 2018: 35).

Lack of Support

It was found that the lack of support from parents and teachers at schools challenged the implementation of active school transport interventions. Parental disapproval was a barrier hampering the encouragement of children to use the Walking School Bus (Smart Mobilitet, 2018). In The Traffic Snake Game intervention, the Mobility Team learned that: "The kids like the campaign. However, many teachers and parents are tired of campaigns" (Smart Mobilitet, 2018: 61). The nudge practitioners all highlight the importance of motivation to change the individual's behaviour: "There must be motivation" (i3), "The intention is critical. The nudged person must have a purpose to change behaviour" (i4) and "If the motivation is too low, you cannot change the behaviour" (i5).

According to the Mobility Team, it is a challenge that once a nudge intervention to promote active transport ends, the participants fall back into old transport habits. The Mobility Team tries to overcome the barrier through local embeddedness to resume the achievements, but Liv stresses that it is "(...) an ongoing challenge and we [ed. the Mobility Team] have not crossed the finish line yet at all" (i1).

Impact Measurement

The Mobility Team face a barrier in its difficulty to document a behavioural change and corresponding impact: "In most of the interventions, we have not been able to measure the economic impact" (i1). Liv partly addresses this challenge to the inability to generalise on small-scale: "It is difficult to provide a number of how much money a given intervention has saved Aarhus Municipality on the roads" (i2). Moreover, none of the interventions included a control group. As a consequence, Liv explains: "so what we have tried to do is to make more qualitative evaluations of projects" (i1). To raise money for a project, politicians look at cost-benefit (i1). The nudge practitioner Ashley supports the cost-benefit approach: "When costs exceed the investment, a nudge should not be applied" (i4) and Catrine explains "ideally,

you run a test to find out if the nudge works. A randomised experiment that demonstrates if the intervention had an effect" (i3). According to Liv cost-benefit is in no small extent, the base on which decisions are made in Aarhus Municipality (i2). As such, it does not support the qualitative evaluation approach in the smart mobility projects: "There is still a lack of political acceptance of qualitative data as a useful tool in political decision-making processes. That it does not always have to be numbered but that other types of knowledge can complement and shed light on the bottom line in a different manner" (i1).

External Factors

A group of external factors were found to impact the interventions. The Mobility Team experienced that the City Bike Trailers were turned into people's property in the form of theft and long-time parking on private addresses (Smart Mobilitet, 2018). Theft also caused problems at the Park & Bike Terminals because they are located in the periphery of a city which poses a risk of a break-in: "We installed locked bicycle boxes at Bike and Park Terminals. But gangs came by and forced the boxes open and stole the bikes. When it has happened once or twice, people stop using the terminals" (i1).

The unforeseen circumstance was a significant barrier to the intervention of Super Commuters. Liv says: "Combination travel was horrible for people. (...) because there are too much unforeseen. The weather plays a part and delays. If you have to change between three means of transport, a bicycle might puncture, a bus is delayed, and a train is crammed" (i1). Catrine stresses that every aspect of a journey must be integrated into active transport interventions: "It is important to take the entire journey into account and not forget important elements, e.g. that the bike is easy and usable in the city right until you need to park it. Then it goes from 0 pct. friction to 100 pct. friction" (i3). Consequently, Liv explains that the Mobility Team did not succeed in mixed-mode interventions.

Changing the physical environment in favour of bicycling has made new barriers apparent in Aarhus. When road space is prioritised in favour of bicycles, Aarhus experiences significant problems because the bicycles take up so much space, that no cars can get through (i1): "The bicycles bike very fast because it is a bicycle street. So we discuss if they should stay bicycle streets on designated segments because street cycle speed increases, making it unsafe for pedestrians" (i1). On the inner-city parts of the Cycle Superhighways, bicycles collide with speed bumps, heavy carriage of goods is problematic. That bicyclists drive on the sidewalk and u-turns (i1) The Department of Urban Development and Mobility also experiences that the concept of shared space causes confusion and insecurity among car drivers, bicyclists and pedestrians who are unaware of where they can move (i1).

A barrier in the aim to nudge Aarhusian to choose active forms of transport was difficulty creating awareness about the different interventions. For example, lack of information about the walking school bus made it challenging to encourage children to use the service (Smart Mobilitet, 2018). Liv also emphasises the lack of best practice in connection with nudge applications to promote active transport. She highlights that only a few well-functioning Park and Bike Terminals are found in Denmark, which limits experiences with the practice (i1). In connection with the European campaign, The Traffic Snake Game, the Mobility Team points to the lack of a national coordinator as a barrier to implement active school transport interventions (Smart Mobilitet, 2018).

5.2.1 Promoters

Political Prioritisation

Liv (2019) highlights the Cycle Superhighways as a positive example of political goodwill towards the bicycle commuters. She further elaborates on positive aspects of integrating the Cycle Superhighways into the light rail and remove some of the hills. Thus, prioritising bicycle commuters into Aarhus is a promoter of the interventions nudging commuters to choose the bicycle as a mode of transport. The Mobility Team experiences that there is a vast political focus in the city council of Aarhus Municipality supporting that children move physically: "This focus is supported by a safety perspective and an educational perspective and is an agenda that we [ed. the Mobility Team] try to solve" (i1). Besides, Liv stresses that active school transport is gaining political attention: "Recently, 1.5 million DKK is set aside to formulate transport policies and facilitate initiatives that are 'soft' and concerns active transport and behaviour" (i1).

Target Group Motivation

In the initial phase of the Smart Mobility project, the Mobility Team conducted several transport habit surveys to map out the characteristics and motivation of the intervention participants. In this connection, Liv explains: "understanding the local community is essential to implement and embed interventions (...) people do not change their transport habits out of idealistic but practical considerations." (i1). The nudge practitioner Thor supports the importance of research before the design of nudge applications: "The most crucial thing in behavioural interventions is test and data. It is undisputed. Without analysis and data, we do not know anything" (i5).

The Mobility Team designed the nudge applications following the participants' needs and motivation to change their transport behaviour. A promoter of the bicycle interventions in Beder-Malling was a health-related focus. Liv elaborates: "[...] as a municipality, the agenda you are hired to lift is not necessarily

the agenda that motivates people to choose active transport. It was the health message that worked" (i1). As such, the Mobility Team communicated benefits such as quality time with family, stress reduction and time in nature in the active transport intervention, as they seemed to encourage participants to engage in the interventions. To benefit from such promoters, Ashley points to the design process of the choice architects: "First behaviour, then attitude. If you start with the attitude to change behaviour, then you get nowhere" (i4). According to experts, "narrowing the target group and studying the underlying barriers to and motivation for a behaviour is important when designing nudge applications" (i3) to "target action and behaviour (i4).

Collaboration

Liv describes how the Mobility Team collaborated with the Health and Care magistrate to change the decision environment by motivational health information (i2). She explains: "within the Smart Mobility project, we were fairly free to spend resources and 'knock at doors' in other departments in the magistrate to explore possible cooperation" (i1). The Smart Mobility project seems to have paved the way to new temporary co-operative ways of working. Several of the projects were carried out as partnerships – both local and nationwide. The collaboration behind Get Cycling was described as 'strong' by the Mobility Team (Smart Mobilitet, 2018: 57).

Community and Infrastructure

The Smart Mobility Team was conscious of carrying out interventions within the structure of participants' existing everyday life. Liv says: "We have had great success on the focused and goal-oriented work in a local community where we could enter into already established communities or groups of residents, use local bicycle dealers, and connect to already existing initiatives" (i1). This strategy seems to have constituted a promoter in connection with the nudge applications. Catrine explains the possible impact: "Nudging has a great effect in areas where you already do something, e.g. send letters or construct bicycle paths" (i3). Liv moreover emphasises that the Smart Mobility project worked in local communities: "We could do that in Smart Mobility because we could decide ourselves for what purpose we would spend the money that was allocated to the suburban areas" (i1).

Besides established communities, infrastructure was also highlighted by the Mobility Team to constitute a promoter. As such, Liv says "it was easier to work with school children and bicycling in the suburban areas. Here, nice cycle tracks are already planned, compared to the inner city [...], which are established a long time ago" (i1). Bicycling and walking infrastructure are stressed by both Liv (i1) and the nudge practitioners (i3; i4; i5) to be decisive to the possibility to apply nudges. Catrine confirms: "Concerning

transport, you cannot apply 'soft tools' – make it easy, fun, and attractive – before the physical elements are present" (i3).

Intensifying Factors

Three examples of promoters were found that, as expressed by the Mobility Team, might have increased the effect of the interventions positively. Firstly, the Mobility Team experienced a synergy effect of multiple interventions: "At one point we had three habit-breaking projects at the same time in Beder-Malling, and people biked on folding bicycles and electric bicycles and were wearing jackets with logos. It created some synergy in the community" (i1). Secondly, the Mobility Team experienced that more extended intervention periods created lasting results in a local area. In the *3*65 Days By Bike and In Tailwind and Headwind, participants borrowed an electric bicycle for 12 and six months, respectively. This has, according to the Mobility Team, enabled the participants to break transport habits to a greater extent (Smart Mobilitet, 2018) Thirdly, the combination of several nudge applications was also experienced to have a positive effect on participants' transport behaviour (i2).

5.2.2 Sub Conclusion Part 2

The findings in this section show that the numerous barriers and promoters, that the Mobility Team experiences while implementing the nudges are either 1) specific, and hence related to a particular intervention or 2) structural, emanating from the political structures of Aarhus Municipality (and in some cases the Danish government) and as such more general across interventions. I identify the structural barriers to include 'political focus', 'lack of resources', 'legislation and permissions' and 'impact measurement' while the barriers specific for interventions cover 'lack of support' and 'external factors'. Concerning promoters, I identify 'political prioritisation' 'collaboration', and 'community and infrastructure' to arise from political structures enabled by the Smart Mobility project. Specific promoters include 'target group motivation' and 'intensifying factors'. An overview of the barriers and promoters are presented in Table 8 and Table 9.

Table 8: Structural a	and Specific Barriers
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Table 9: Structural and Specific Promoters

Barrier	Structural	Specific	Promoter	Structural	Specific
Political Focus	x		Political Prioritization	x	
Lack of Resources	X		Target Group Motivation	L 	х
Legislation and Permission	x		Collaboration	x	! ! !
Lack of Support		x	Community and	x	! ! !
Impact Measurement	x		Infrastructure	· ·	
External Factors	 	x	Intensifying Factors		х

5.3 Findings Part 3 – Levels of Relations of Nudges and Barriers and Promoters

The following section illustrates what levels of influence the different types of nudges (Findings Part 1) have in relation to barriers and promoters (Findings Part 2) in the active transport interventions by the use of the social-ecological model (Larouche & Ghekiere, 2018).

To encapsulate the complex pattern of interrelatedness between nudges and barriers and promoters around the design of the active transport interventions, the following brief comments on the target group size of the different interventions. The nudges identified in Findings Part 1 are applied across clusters of interventions based on the target group size. The interventions targeting small groups of participants (365 Days By Bike, In Tailwind and Headwind and Super Commuters) generally applied the following nudges: the uses of social norms, increases in ease and convenience, pre-commitment strategies and eliciting implementation intentions. Interventions with a larger target group (Walking School Bus and The Traffic Snake Game) nudged through the uses of social norms, warnings, graphics or otherwise and pre-commitment strategies. The population-based interventions (City Bike Trailers, Bicycle Library, Get Cycling, Park and Bike Terminals and Cycle Superhighways) overall applied a combination of two nudge consisting of warnings, graphics or otherwise together with either increases in ease and convenience or built environment. Lastly, only one nudge, increases in ease and convenience, was identified in the work-place based intervention (Visible Electric Bicycles). It should be noted that small and large are referring to the size of the target group (number of participants) and should not be confused with small-scale or large-scale interventions.

5.3.1 Clusters of Patterns of Relatedness

By breaking the above-mentioned target groups further down, a resemblance of patterns of interrelatedness within clusters emerge. The clusters are still characterized by the size of the target group but also characterized in terms of similar intervention designs.

The cluster of interventions containing the smallest target groups are 365 Days By Bike (1), In Tailwind and Headwind (2) and Super Commuters (3) and, as described in Findings Part 1, they share a similar intervention design. These three interventions apply four types of nudges oriented at the levels of influence most proximal to the individual's active transport behaviour in the social-ecological model (Larouche & Ghekiere, 2018); uses of social norms (community level), increases in ease and convenience (interpersonal and personal level), pre-commitment strategies (interpersonal and personal level) and eliciting implementation intentions (individual level). In these interventions (1-3), the Mobility Team

experiences structural barriers at the policy level, including lack of resources, difficulties measuring impact and unfavourable political focus. Both specific promoters (target group motivation, intensifying factors) and structural promoters (collaboration, community and infrastructure) appear to impact the ability to implement nudges positively. The promoters influence the interventions at all levels in the sociological model, with most of them emanating from the policy level and the built environment level. The pattern of influence of both structural barriers and structural promoters seems to indicate that the Mobility Team, through the Smart Mobility project, was able to overcome the barriers by decision authority over project resource allocation and by nudging participants in a suburban area with infrastructure and community support. As such, the structural promoters seemed to overcome the structural barriers in the setting of the Smart Mobility project.

The two active school transport interventions, Walking School Bus (4) and The Traffic Snake Game (5), target the youngest students in the primary school. Three types of nudges were identified primarily seeking to influence students transport behaviour through the individual level (pre-commitment strategies) and the community level (uses of social norm and warnings, graphics or otherwise). Though political prioritization is a promoter of the interventions (4-5), the Mobility Team experienced both structural barriers (lack of safe walking and bicycle infrastructure, school policies and lack of resources) and specific barriers (lack of parental and school support). The structural barriers cause the specific barriers that impact active school transport behaviour.

The third cluster of interventions only contains the Get Cycling (6) intervention targeting all Aarhusians, thus population-based. This intervention (6) applied similar nudges as the active school transport interventions: pre-commitment strategies (individual level), uses of social norms (community level) and warnings, graphics or otherwise (individual level). However, the intervention (6) did not face the same barriers as active school transport interventions (4-5). This suggests that population-based interventions are more self-driven than interventions aiming at a smaller target group. The only barrier highlighted by the Mobility Team was that the app development was cost-heavy (Smart Mobilitet, 2018). As such, in the population-based interventions like Get Cycling, the Mobility Team does not have to 'sell' the intervention, the same way as schools and parents must be convinced to embed and support the active transport interventions. Partnerships were identified to be a strong promoter.

In the two interventions Bicycle Library (8) and City Trailers (9) the use of the two nudges, increases in ease and convenience and warnings, graphics and otherwise, sought to change Aarhusians transport behaviour through the individual level in the social-ecological model (Larouche & Ghekiere, 2018).

Primarily specific barriers (external factors) and to some extent, structural barriers (lack of resources) influence the access to trailers and bicycles, e.g. when people did not return the rented bicycle or trailer. The same way as the intervention Get Cycling, the rental system interventions (8-9) were made possible through partnerships and collaboration. Hence partnerships and collaboration constitute a promoter with reciprocal impact on the nudge application.

Finally, in the population-based interventions Park and Bike Terminals (10) and the Cycle Superhighways (11) structural promoters (political prioritization and community and infrastructure) at the policy level of influence enabled the Mobility Team to change the built environment and nudge through warnings, graphics or otherwise. The built environment in the social-ecological model (Larouche & Ghekiere, 2018) is a vital level of influence for active transport behaviour and as such, a promoter for nudge applications.

It appears, that the smaller the target group, the more structural barriers at the policy and built environment levels of influence are experienced by the Mobility Team in their work to exert influence. Consequently, the interventions are designed around nudge applications targeting the individual, interpersonal and community level of influence. In the other end of the scale, population-based interventions enable built environment nudges and are influencing active transport behaviour through policy and built environment levels.

5.3.2 Overall Patterns of Relatedness

In continuation of the description of clusters of patterns, some relations can also be seen as overall patterns. In the following, three examples of relatedness are presented. Firstly, it appears that partnerships and collaborations (enabled through political influence) help to overcome the structural barriers concerned with lack of resources and a political focus (also at the policy level) that do not favour active transport. Partnerships provide human and capital resources and are thus identified as a promoter. But partnerships are time-consuming, and the involvement of multiple stakeholders increases the complexity of planning, designing and applying nudges. As such partnerships do not only constitute promoters but also complicates nudge application in active transport interventions. Secondly, some types of nudges are enhanced or hampered by specific promoters and barriers. For example, the structural barrier concerning legislation and permission impacted the Mobility Team's ability to apply the warnings, graphics or otherwise nudge due to strict rules about signage and information channels. It challenged the Mobility Team's ability to create awareness about campaigns and interventions. The uses of social norms were mainly applied in small scale interventions in which embeddedness in local communities and schools acted as promoters to anchor behavioural changes. The data shows that the Mobility Team's ability to use

the power of social norms at the community and interpersonal level of influence was both hampered by lack of support (parental disapproval or campaign tiredness) and enhanced by target group motivation (ambassadors). Thirdly, it seems that the different types of barriers and promoters pertain to certain levels of influence. Structural barriers were mostly found at the policy level exerting influence on the Mobility Team's ability to apply built environment nudges. The intervention-specific barriers primarily impacted nudge application oriented at the individual and community levels. Structural promoters were enabled by the Smart Mobility project influencing the policy level, and the specific promoters were found to exert influence in nudge applications at the individual level and the community level.

5.3.3 Sub Conclusion – Part 3

The findings in this section show that types of nudges are related to barriers and promoters at various levels of influence in 1) clusters of patterns of relatedness based on target group size and 2) overall patterns of relatedness across active transport interventions. In connection to clusters of patterns, it appears that the smaller the target group, the more do the structural barriers exert influence at the policy and built environment level, hence nudge applications target the individual, interpersonal and community level of influence. On the contrary, it appears that population-based target groups are influenced by structural promoters at the policy level. As such, built environment nudges are used and nudge application at the individual level is enabled through partnerships at the policy level. Three main overall patterns of relatedness between nudges, barriers and promoters were identified. Firstly, within the policy level of influence, the findings indicate that partnerships and collaboration help overcome structural barriers to apply nudges and implement interventions. Secondly, certain promoters appear to pertain to the policy level of influencing, whereas specific barriers and promoters primarily influence nudge application oriented at the individual and community levels.

The various patterns of relations of nudges and barriers and promoters across levels of influence are attempted exemplified in Figure 8. To simplify the complex patterns of relations, interventions (1-11) are plotted together with barriers and promoters, and not applications of nudges. The figure does not contain the relatedness between every barrier or promoter and intervention identified in this study as this would result in a chaos of arrows. Instead, an example of clusters of patterns of relatedness is provided for The Walking School Bus (4) and The Traffic Snake Game (5).



Figure 8: Levels of influence and relatedness of nudges, and barriers and promoters for Waking School Bus and The Traffic Snake Game.

6. Discussion

This section sums up, discusses and critically reflects on the findings in connection to the overall research question: 'How are nudges and barriers and promoters interrelated in and influence the application of public policy interventions promoting active transport?'

Summary of Findings

This section begins by bringing the findings together to address how nudges and barriers and promoters are interrelated. The types of nudges identified in the findings include: uses of social norms, increases in ease and convenience, pre-commitment strategies, eliciting implementation intentions, warnings, graphics or otherwise, and built environment. As seen in the findings, up to five types of nudges were combined in the active transport interventions in Aarhus and resemblance was found across interventions in terms of types of nudges applied. In addition, numerous barriers and promoters were found to influence the implementation of nudges being either specific, hence related to a particular intervention, or structural, emanating from the political structure of Aarhus Municipality (and in some cases the Danish government). The structural barriers include: 'political focus', 'lack of resources', 'legislation and permissions' and 'impact measurement', while the specific barriers cover: 'lack of support' and 'external factors'. Structural promoters were enabled by the Smart Mobility project and comprise: 'political prioritisation', 'collaboration', and 'community and infrastructure' whereas specific promoters include 'target group motivation' and 'intensifying factors'. Finally, relations between nudges, and barriers and promoters formed patterns around clusters of interventions based on target group size and overall across interventions. The patterns of relations emerged across all levels of influence (policy, built environment, community, interpersonal and personal), however the most influential barriers and promoters were traced back to the policy level.

A Negative Feedback Loop

Based on the summary of findings, the following discusses how the relations between nudges and barriers and promoters influence the application of active transport interventions. More specifically, this section focuses on the influence of the policy level in connection to the application of interventions as the most influential barriers and promoters emanate from the political context of the case.

The use of people-oriented interventions using soft tools such as nudges is a relatively new policy approach in Aarhus to influence people's transport behaviour. This new policy approach was initiated as part of the Smart Mobility project in 2014. Different cost-effective means and methods in active transport

interventions were developed, tested and evaluated to support an ambitious urban development plan set by Aarhus City Council as an alternative to a traditional infrastructure-oriented approach. The interventions presented in this study, besides the Cycle Superhighway, were all small-scale projects. The experiences learned from the small-scale projects should ideally, in the long run, enable the Department of Urban Development and Mobility to implement active transport interventions on a large scale from an informed basis. As a result of this, truly making an impact by targeting a large population and underpinning the urban development plan. However, the findings indicate that the Mobility Team seems to be caught in a circular pattern where they do not look to reach a level where they can engage in large scale and long-term interventions. The Mobility Team experiences that the share of resources within the Department of Urban Development and Mobility allocated to active transport, including communication and behaviour, is not sufficient (A). Due to this matter, the Mobility Team is entailed to carry out smallscale active transport interventions. The short-term perspective of these interventions does not enable the Mobility Team to document a continuing behavioural change among participants (B) nor does the qualitative evaluation methods or research design allows the Mobility Team to document a measurable change in active transport behaviour that fits into the cost-benefit model that Aarhus municipality employs to analyse projects and make decisions (C). With no proof of effect, from the perspective of political decision-making measures, behavioural active transport interventions are not granted more resources or given more attention (D). Consequently, The Mobility Team seems to be caught in a loop of limited resources and small-scale projects unable to prove that nudging is a useful policy tool to promote active transport (see Figure 9).

Figure 9: Negative Feedback Loop



Nudging is Not a Quick Fix

Nudges are often presented as simple and easy to implement, hence cost-effective. This case implies that nudge application and choice architecture changes in the context of active transport promotion is rather

complex and resource-demanding. Thaler & Sunstein (2008) as well as the nudge practitioners Thor, Catrine and Ashley (i3; i4; i5) emphasize the importance of evidence and testing before the implementation of nudges. The Mobility Team employed this approach in the Smart Mobility project. In the small-scale interventions, collecting data of target group behaviour and characteristics preceded intervention design and implementation following evaluation to test full-scale potential. The approach appears to have provided the Mobility Team with valuable knowledge on active transport behaviour and behavioural response to the interventions.

The Mobility Team has been able to detect behavioural changes, however, for the behavioural changes to stay permanent and become a 'new' transport habit it is essential to encourage the target continuously. This endeavour has not been feasible through the design of the interventions in the Smart Mobility project as these are short-termed. For nudging to reach its full potential projects should be scaled. In this context, scaling not only refers to an increase in the target group but more importantly refers to the shift from temporary project-based interventions to interventions that are operated and maintained continuously. With this, interventions and nudges in the context of active transport should not be perceived as a quick fix.

When is Nudging the Right Policy Tool?

In light of the complex and multi-sectoral context of active transport and comprehensive resources associated with nudge application, one question naturally arises: when is nudging the right policy tool? Looking at the question from an economic point of view, the answer would point to a cost-benefit analysis, in line with the perspective of Aarhus Municipality. The nudge practitioners stress how nudging is one tool out of many from which policy makers can choose and that when costs exceed benefits, one should not apply nudges (i4; i5). Thaler and Sunstein (2008) also emphasize the cost-benefit analysis to choose from different choice options (Sunstein, 2013; Thaler & Sunstein, Nudge: Improving Decisions About Health, Wealth and Happiness, 2008). In contrasts, the case shows that the Mobility Team is in no position to document an effect of the active transport interventions based on a cost-benefit analysis (except for in the case of the Cycle Superhighway). As such, one should evaluate if a cost-efficient framework goes well in hand with active transport interventions and nudge application. Instead, the application of active transport interventions and nudge application. Instead, the application of active transport interventions from a desire to obtain specific active transport behaviour, if several examples of nudges or choice architecture do not bring about the intended behaviour, then other policy tools – including legislation – could be the solution. From the perspective of the Mobility Team,

the interventions prove that nudging and choice architecture holds potential as a policy tool to promote active transport.

A Need to Change Organisational Structures

The interrelatedness of barriers in the policy level paints a picture in which the organizational structure of Aarhus municipality seems to be critical to the application of interventions and with this nudges in public policy. In the Smart Mobility project, the Mobility Team had the decision authority to decide how resources were spent, what working procedures were suitable and with whom to work. This working context seems to have fostered the Mobility Team's ability to use nudges and to have nurtured promoters of active transport. However, now as the Smart Mobility Project has come to an end, the Mobility Team is, as a consequence of the structural barriers within Aarhus Municipality, struggling to find the money and mandate to design the choice architecture and to nudge through interventions. Moreover, being part of a political organization, the Mobility Team experiences how continuous organizational restructuring dissolves the informal networks they have spent time to build across departments and how long bureaucratic work processes hamper both the scale of and ability to implement nudge applications. Hence, nudging to promote active transport is not only a matter of changing the behaviour of the citizens of Aarhus, but it is also a matter of changing the system of Aarhus Municipality. Viewed in this light, influencing the actual active transport behaviour of Aarhusians seems to be secondary to a much greater task of organisational change internally in Aarhus Municipality. As such, the findings of this thesis suggest, that to use behavioural interventions including nudges as a public policy tool to promote active transport can only be possible with support and acceptance from stakeholders in the political context.

7. Concluding Remarks

To round off this study, this section focus on managerial implications and suggestions for future research.

7.1 Managerial Implications

In this section, I dive into the managerial implications for applying nudges in interventions to promote active transport in Aarhus Municipality that this study puts forward. Taking a pragmatic approach, the underlying objective of this study has been to enlargen the knowledge of how nudges and barriers and promoters are interrelated and how this influence the application of active transport interventions in Aarhus. The following recommendations are directed towards the Mobility Team. However, some of these insights could also be interesting for choice architects, in general, trying to promote active transport.

At the time of the last interview with Liv, no interventions to promote active transport were in the pipeline in the Department of Urban Development and Mobility. The following recommendations should be seen in the light of future active transport interventions applying nudges to promote active transport.

Account for Different Levels of Influence When Designing Nudges

As presented in the findings, it appears that various barriers and promoters influence the application of nudges in active transport interventions at multiple levels. To take into account the different levels of influence when designing nudges, I propose that the Mobility Team performs a risk assessment. In the risk assessment process, the Mobility Team first identifies barriers and promoters that might influence a specific nudge application, then analyse their significance, establish ways to mitigate the barriers or benefit from the promoters and decide on the option that is likely to be the best fit. For example, when the Mobility Team applies nudges that change the built environment or physical environment, e.g. erecting campaign posters or painting road markings, they are met with strict legislation from the Danish Road Directorate amongst others. As such, the Mobility Team needs to have control of law and obtain necessary permissions before planning the interventions. Another example shows that the combination of nudges that increased ease and convenience, triggered intention to change, ensured pre-commitment and used social norms to encourage bicycle commuting did not end in the desired behaviour for participants with small children (i1). Though participants were motivated for a lifestyle change, solely relying on cycling as a mode of transport was not feasible for these families. Therefore, the Mobility Team should go for the low-hanging fruit and target motivated families with older children.

Replacing the Mobility Team in a New Organisational Setup

The findings indicate that an in-house behavioural insights team working across sectors and departments in the magistrate would benefit the promotion of active transport interventions. Inter-disciplinary collaboration between the Department of Urban Development and Mobility, the Department of Health and Care, the Department of Children and Young People and the Climate Secretariat (i1) already took place during the Smart Mobility project. The magistrate departments mentioned above do all, to a certain degree, share an agenda on active transport even though the goals and means might differ. For example, physical activity can improve health and bring savings in healthcare costs (the Department of Health and Care), active modes of transport may reduce greenhouse gas emissions (the Climate Secretariat), and physically active children often perform better in school and experience less anxiety (the Department of Children and Young People). As such, transforming the Mobility Team into a cross-sectoral behavioural insights team could be a way to manoeuvre through the political landscape and obtain support and resources for active transport interventions instead of competing for it.

External Partnerships

Given the limited resources allocated to active transport promotion, it is recommended that the Mobility Team further explores the potential of active transport interventions through external partnerships. Building interventions and with this nudges and choice architecture around partnerships give the possibilities of obtaining valuable insights from interest groups besides pooling resources. The Mobility Team already engaged in partnerships in connection with the Get Cycling intervention (multiple partners), The Traffic Snake Game (European campaign), the Walking School Bus (Aarhus University, TrygFonden and Dansk Skoleidræt), and City Bike Trailers (Aarhus City Bikes). For the future, however, the Smart Mobility Team may consider building partnerships with more local organisations and institutions. The findings of this study show that many of the interventions do not affect participants' active transport behaviour after the end of the project. Moreover, tying the interventions into locally embedded structures seem promising. Therefore, building partnerships around new active modes of transport with organisations that are already locally embedded provides opportunities to carry on active transport behaviour and continuously trigger good intentions.

Active Transport Interventions vs. Other Types of Policy Tools

As brought out in the discussion, in some instances, nudging is not necessarily the right policy tool to promote active transport. As suggested in the section, these include situations in which costs exceed benefits or where the intervention in earlier projects has not been effective (e.g. caused the desired behaviour). Findings indicate that some of the nudge applications in active transport interventions require high amounts of financial and human resources. As an example, in Tailwind and Headwind, it took the Mobility Team numerous of working hours and resources to maintain participants' involvement and feedback (i1). The intervention In Tailwind and Headwind included only ten participants (five couples). Even though the upscaling potential is high, the resource requirements are considerable, and the Mobility Team does not seem to be able to allocate these amounts of resources.

7.2 Future Research

In the following, I present two potential research proposals for further research.

Two Comparative Case Studies

As a natural continuation of the findings of this study, I suggest conducting a comparative case study of nudge applications in active transport interventions in other big cities like Odense, Copenhagen and Aalborg. A comparative case study would lay the foundation of a more general and robust understanding

of nudge application in active transport interventions in contexts other than the Mobility Team in Aarhus Municipality. As mentioned in section 4.2.4, this case appears to be an extreme case due to the level of political support and infrastructure compared to Odense Municipality and Copenhagen Municipality. However, it would be interesting to investigate if choice architects focusing on active transport in these two cities employ the same types of nudges, if they experience the same barriers and promoters when applying the nudges and if the same overall negative feedback loop is present. These findings would allow for verification or falsification of the findings of this study and thereby improve generalisability and contribute to best practice in the field of nudge applications and active transport interventions.

Adding a Temporal Perspective to the Conceptual Framework

Yet another interesting future research opportunity is to add a temporal perspective to the conceptual framework. The conceptual framework applied in this study is compiled by types of nudges (Sunstein, 2014), the empirically driven factors of barriers and promoters and the social-ecological model (Larouche & Ghekiere, 2018). However, the framework does not explicitly take into account *time* as a variable. The findings and discussion indicate that time has a say to how the application of nudges and barriers and promoters are related in and influence active transport interventions. As discussed, the overall pattern in this case emanates as a circular notion of which political prioritization of resources only suffice smallscale interventions that cannot document a measurable change in active transport behaviour and thus the interventions, despite implying positive impact, are not up-scaled. It could be interesting to dig even deeper into this matter, by applying a temporal perspective, thereby, investigating how barriers and promoters and the choice of nudge application as a policy tool changes with experience. According to pragmatism, the philosophical underpinning to this study, the reality is understood as a flux of processes and obtaining an understanding of how a phenomenon evolves is a substantial mean to understanding to the phenomenon itself. This future study proposition would especially have relevance to practitioners as the study potentially could guide them on how to move from pilot projects to scale projects breaking the 'negative' circular pattern and how to manoeuvre the challenging political landscape.

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