Nudging Towards Sustainable Urban Mobility

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Preface

Rapid urbanisation is increasing the density of cities and worsening issues of congestion and pollution. How cities respond to this will vary across regions and even between cities within the same country as each differ in terms of population, level of development, and cultural diversity.
Each city forges its own path to enhance its citizens' health and quality of life in holistic ways through new technology and alternative and green modes of transport. One strategy has been to focus efforts on changing behaviour through behavioural intervention tools known as nudges – changes in the environment in which decisions are made. Although nudging has become better known among transport authorities and mobility providers, the effect of its influence varies across studies and cities. This report examines nudges applied in transport and mobility sectors by assessing research literature, practice-based reports, and practical examples from around the world, including Singapore, South Korea, Europe, and the United Arab Emirates. The aim is to shed light on promising practices, evaluate the impact and effectiveness of nudges in practice, and show how practices from various regions can be used to change mobility behaviour. Practitioners can use this report to learn from other regions as well as to review and adjust their transport practices and initiatives in order to better serve their citizens.

1.
Introduction: Why Are We Interested in Nudging?

Cities are the engine of the global economy and are home to more than half of the world's population. The list of factors affecting people's experience of living in them is long – housing, pollution, demographics, to name a few. Mobility is one such factor, but it is one of the more critical components of urban life. How a city's residents move about reliably, comfortably, conveniently, and affordably, all figure into the overall wellbeing of citizens and the attractiveness of a city.

The transportation sector is one of the largest producers of global CO2 emissions, accounting for 7.2Gt CO2 in 2020. Passenger road travel, including light duty vehicles and buses, account for nearly 50% of transport emissions, with light duty vehicles contributing the majority (IEA , 2020). Vehicle sales had already started to rebound in 2020 in countries where lockdown restrictions had begun to ease. As a consequence, road transport activity is projected to return to pre-COVID-19 levels, with CO2 emissions expected to be only 5% lower than in 2019 (IEA, 2021). Moreover, global transportation demand is expected to climb as the global population grows and incomes rise. By 2070, the International Energy Agency (IEA) predicts global transportation to quadruple, automobile ownership rates to rise by 60%, and demand for passenger and freight aircraft to triple. When these elements are combined, transportation emissions can be expected to surge (IEA , 2020).

The COVID-19 pandemic, along with changes in consumer preferences, technology, and regulations, have contributed to and will continue to contribute to major mobility shifts. The pandemic has disrupted mobility, leading to citizens becoming more focused on health and altering their habits and preferences to avoid infection. This means that many may favour the use of private cars over public transport or shared mobility services. In addition, there is an increased focus on digital channels and sustainability issues with expectations of expanded online offerings from mobility players as more customers use these channels for reviewing services, booking, and payments. Access to micro mobility options – bicycles, e-scooters, and mopeds – and enabling inter-modal commuting will also be important (McKinsey , 2020).

Long-term ecological sustainability must be addressed via sustainable mobility, which may be done in part through technical innovation and the use of clean energy. Sustainable mobility, on the other hand, should fulfil individual travel demands while also providing better equity in terms of ease, access to transportation alternatives, and affordability. This means that the social and environmental aspects of sustainable mobility are just as essential as the technology and efficiency aspects. However, technology alone will not address the problem of sustainable mobility. The mere availability of new mobility options does not contribute to beneficial outcomes if citizens do not exploit such options. To properly adopt and sustain these new solutions, we must also understand the citizens themselves, their routines, and their behaviours.

To induce behavioural changes, the transport sector has traditionally focused on hard measures such as changes to physical and technological infrastructure, pricing mechanisms, or pollution standards. On the other hand, soft measures rely on the provision of information or the ability to persuade citizens to change their attitudes, behaviour, and subsequently, actions. One such measure for changing behaviour identified by behavioural economics research is nudging, which forms the focus of this report. Nudges help people carry out desirable behaviours by making those behaviours easier and more attractive. While they have been shown to be effective tools for achieving behaviour changes in a variety of domains, including sustainability (Hummel & Maedche, 2019; Bonan, D'Adda, Cattaneo, & Tavoni, 2020; Trudel, 2019), it is not clear whether they can adequately induce changes in commuters in the transport and mobility sectors. Hence, the purpose of this report is to provide an overview of research literature and practice-based reports on nudge interventions and compare them with nudges applied in practice MaaS platforms, mobility apps, and pilot projects to determine whether these nudges increase sustainable transportation use.

2.
Methodology

The research method and data collection are comprised of several elements. Nord University's library database and Google were utilised to gather relevant case studies. To search for scientific publications on the topic of nudging, keywords such as 'nudge', 'behaviour economics', 'transportation', 'smart city', and 'mobility' were used. In line with the focus of the report, only research studies that fell into the transport and mobility domain were considered. The studies included nudge implementations or proposed trials in the field. In addition, practice-based reports and press materials from transport authorities and research institutes were also considered to assess the impact of nudges compared to research studies. In total, approximately 40 research papers and reports were analysed. Lastly, practical applications of nudges in sustainable mobility initiatives, transport, and mobility services apps, and MaaS applications were identified and illustrated (Appendix 1). Real-world examples and case studies were considered from diverse global regions and cities to examine how nudges are applied in different cities and contexts.

Thaler and Sunstein's (2008) work was used as the starting point for the theoretical background of nudging, i.e., behavioural economics, and identification of the various nudge interventions. Attempts were made to gather sufficient research studies for each nudge identified by Thaler and Sunstein (2008). However, it soon became clear that there were not enough evidence-based studies as the field of nudge applications in the transport sector is still emerging. Furthermore, studies of interventions tended to focus on certain nudge interventions or implemented a combination of two or more nudges at a time, which made it difficult to ascertain the impact of each individual nudge. Incentives is one such example that was noted as being utilised by transport operators and investigated in research studies as a strategy for transport demand management. However, whilst it is not part of the group of nudges identified by Thaler and Sunstein (2008), it warrants attention as it is used in conjunction with other nudges. As most commuters use apps and online platforms to conduct their mobility transactions, it is equally important to consider the use of nudges in online settings. Elements of gamification were seen to be used as a nudge to steer commuters towards more sustainable modes of transportation, hence the need for its consideration in this report.

Thus, for ease of readability and understanding for the reader, the behavioural intervention strategies were grouped into sub-sections that were related to gamification, incentives, defaults, and perceptions. Subsequently, Chapter 3 provides illustrations of nudges applied in diverse countries such as Singapore, South Korea, Europe, and the United Arab Emirates.

3.

Literature Review: What Does Research Tell Us?

Neoclassical economics assumes people are logical beings capable of making rational decisions based on a consideration of all the available information and choices. In contrast, behavioural economics incorporates knowledge from the field of psychology to illustrate the boundaries of rationality in people's decision-making abilities and assumes decisions are largely driven by automatic behavioural patterns or emotions which might not always be in our best interests (Iyengar & Lepper, 2000; Bothos, prost, schrammel, roderer, & mentzas, 2014). Meanwhile, others argue that there is no concrete evidence that the ability to make decisions is compromised by the availability of several choice options (Chernev, Boeckenholt, & Goodman, 2015; Scheibehenne, Greifeneder, & Todd, 2010).

The concept of nudging is based on behavioural economics (Hummel & Maedche, 2019). Behaviour is largely driven by the context in which the decision is made, i.e., the choice environment. It assumes the choice architecture can be used to alter behaviour. For example, assuming that individuals are willing to donate their organs unless they declare otherwise (i.e., setting the default to an opt-out mechanism) dramatically increases the percentage of organ donors (Ortmann & Dixit, 2017).

Nudges are becoming increasingly important in today's digital age as more frequent decision making is taking place in online platforms. This increases the relevance of research on digital nudges – changes in the user interface design elements – to see what can be (not) transferred from the study of nudges in offline settings.

People's mobility decisions and behaviours can greatly impact congestion, pollution, traffic time, and commuting costs. As urbanisation continues and the density of urban centres increase, measures to alleviate these pressures can save time and money by facilitating the increased proximity of mobility services and productivity that enhance economic wellbeing. Nudges as an alternative to hard measures, such as zonal congestion charges, can encourage individuals towards more socially optimal travel decisions without restricting their choices. Such nudges may be cheaper and less controversial and, in certain circumstances, be just as effective. An understanding of various nudges can help to develop a toolkit to enhance sustainable mobility behaviour. The following sections provide a brief introduction to the concept of nudging and an overview of the research into various nudge tools from the literature.

3.1.

A Short Primer on Behavioural Economics and Nudging

Coined by Thaler and Sunstein (2008), nudging is about designing the choice architecture to steer people towards a particular direction. Their aim is to encourage behaviours and decisions that are supposed to be beneficial to society and to the individual, as opposed to changing the value system. To be classed as a nudge, these behavioural interventions must be easy to avoid and not restrict the available choice options or change the incentives (Ortmann & Dixit, 2017; Vanolo, 2018). Taxes, subsidies, mandates, and bans are not nudges. Nutritional information about the number of fats, calories, and protein on a cheeseburger package is a nudge. A warning sign regarding the dangers of swimming at sea during high currents is a nudge. Referring to the aforementioned cognitive biases, it can be deduced that behavioural interventions of the nudging kind may be appropriate when choices are complex or have delayed effects, when immediate feedback is not available, or when the correlation between the choice and outcome is ambigiuous (Alpine Space, 2019; Mont, Lehner, & Heiskanen, 2014). Most of our everyday actions are borne of automatic habits or routines such as not 'choosing' to leave the lights on when leaving the room. People often make decisions that are not necessarily always in their best interest due to cognitive biases or simply because they are impulsive, busy, or short on time. Thus, the bulk of decisions that are not consciously reflected upon is the area of application for nudges. Some evidence suggests that nudges may be more effective if they are unobstrusive, are perceived as legitimate by the individual (meaning they help the individual to achieve what they want), and when they are in line with or build upon the potential user's values and choices (Costa & Kahn, 2013; Gössling, 2013).

Nudging is one particular area of behavioural economics which applies psychological insights into human behaviour to study the effects of social, emotional, cognitive, cultural, and psychological factors on the economic decision making of individuals and institutions (Ortmann & Dixit, 2017).

Human decisions are largely driven by automatic behavioural patterns or emotions because of our limited rationality, limited willpower, and limited self-interest, which prompts the development of cognitive biases and/or shortcuts (Thaler , 2015). According to Benson (2016), this happens due to the following reasons:

1. Information Overload: On a daily basis, we are bombarded with a great deal of information. As a result, we have no choice but to filter out the majority of the information we receive and to select the pieces that will most likely be helpful and beneficial in some way. We are more likely to remember things that are unusual or surprising, already in our memory and repeated often, and details that confirm our existing beliefs.

2. Making sense of incomplete information: The world is a confusing place, and we need to make sense of it in order to continue. When we do not have all the information, we tend to connect the dots by using information we believe to be true in order to update our mental view of the world. We simplify complex probabilities to make sense of them, find patterns and stories, and fill in gaps with best guesses or stereotypes.

3. The need to make quick decisions: time and information constraints force us to quickly assess situations and act fast. We tend to favour options that are immediate and relatable, that preserve our status quo and autonomy, and that are quick and simple to execute.

4. What should be remembered? The information overload that we receive on a daily basis means we need to make trade-offs on the information we remember. For example, we discard details to form generalities, edit details in memories that were not there previously, or store memories according to how they were experienced. What is chosen to remember is what is most likely to inform our biases toward 'information overload', as well as inform what comes to mind when we need to make sense of something ('lack of meaning').

Thus, it is fair to deduce that behaviour is driven by the context in which decisions are made, i.e., the choice architecture (Thaler & Sunstein, 2008). A website designer may format certain information in large fonts, information they want the customer to notice and likely choose, while information is formatted in a smaller print at the bottom of the page. Such small differences in the architecture can have a significant impact on the decisions people will make. A choice architecture where people can opt out rather than being forced to opt in can have a wide range of outcomes (WEF, 2021).

Although qualitative and quantitative systematic reviews have been conducted on the topic of nudging before, they have been limited to certain topics such as healthy eating or energy consumption (Butcher , et al., 2016; Lycett, et al., 2017). Hence, specific conclusions can only be drawn for those contexts, but they do not allow for a generalised view on nudging nor for a cross-context comparison (Hummel & Maedche, 2019). Some argue that nudges can run the risk of social manipulation and freedom of expression by subjectifying who is 'good' and 'bad' at distinguishing between appropriate behaviours and inappropriate behaviours and stigmatising them. This could be particularly true in the case of environmentalism and green citizens (Vanolo, 2018). Furthermore, insufficient understanding of how to use nudges can have unintended consequences. For instance, a default applied in the wrong environment can steer the individual to opt out at the wrong moment (Hummel & Maedche, 2019).

Nudging is about designing the choice architecture to steer people towards a particular direction.

3.2
Nudging in Transportation and Mobility

Nudge measures have proposed various ways to steer people toward decisions and behaviours that are deemed preferable for individual and societal wellbeing (Sunstein, 2014). These methods can be applied to design choice architecture in both physical spaces and web-based or mobile applications. Table 1 illustrates nudges identified by Thaler and Sunstein (2008).

The following sub-sections provide an overview of most evidence-based and researched nudges in the transportation sector based on literature research, practice-based reports, and practical applications. The sub-sections do not provide examples for each of the nudge categories illustrated in Table 1. As nudges are usually implemented in conjunction with other service improvements or regulations, it is difficult to disentangle the impact and effect of a specific nudge since in most cases several nudges are carried out at the same time. Gamification is a relatively new and emerging field of research for digital nudge application in the mobility sector. Although it is a limited body of research, it is addressed here because mobility operators need to understand how to frame information and services on online platforms to induce behavioural changes. Incentives are technically not a nudge as they usually involve provision of financial measures to encourage actions and/or behaviours. However, it is a common strategy used by transport operators in conjunction with other nudges for further encouragement of sustainable mobility behaviour. Perception biases and excessive reliance on defaults (default biases) are a result of limited rationality, which nudges can help to influence and counteract. Framing nudges based on this understanding can help to influence mobility behaviour.

Framing nudges based on this understanding can help to influence mobility behaviour.

Table 1
Overview of Nudges Identified by Thaler and Sunstein (2008)

	Type of Nudge	Explanation	Example
1	Changes in the physical environment	Facilitate the desired behaviour by changing physical surroundings	Dedicated parking for bicycles, dedicated bicycle lanes
2	Default	Make the desired choice the default selection or setting. In many contexts, default rules are inevitable as it is too burdensome and time consuming to require people to choose	Automatic enrolment in health care plans
3	Simplification	Make the tools that people use to make decisions (i.e., websites, apps, forms) easy to understand and navigate	Simplify travel data into easy-to-understand visuals with the most important or relevant info appearing on the main page
4	Social Norms	Emphasise what most people do. The information needs to be as specific and local as possible	90% of pedestrians do not walk in the dedicated bicycle lanes
5	Increase ease and convenience	Reduce barriers (including the time it takes to understand) to make the desired behaviour the most convenient to choose	Show the environmental or economic costs associated with riding a private vehicle rather than using public transport clear and visible on the app
6	Warnings and graphics	Use of large and bold fonts, clear colours to grab attention. Can be combined with explanation of steps that need to be taken to reduce the risk	Display warning for going above a certain limit of CO2 emissions
7	Commitment	People are more likely to act in line with certain goals if they have committed themselves in advance to certain actions, preferably at a precise moment in the future	To save a certain amount of money by using public transportation
8	Reminders	Provide reminders via push notifications, email, or text message. Timing is important to ensure people act immediately on the information	Soon to be expiring ticket reminder
9	Intentions	When people are given an implementation intention or their identity is emphasised, they are more likely to engage in activities	Emphasising identity: The Green Traveller
10	Information about previous choices	Provide access to information about previous choices and their consequences	Emissions related to travelling, amount of money spent on petrol for a specific period of time vs. amount of money spent if public transport was used
11	Feedback	Give feedback on the action or the desired behaviour	Speed control monitors around school areas showing whether the driver is above or below the speed limit with a 'smiley' or 'sad' face
12	Disclosure	Make information available and comprehensible	Illustrate the economic or environmental cost of travelling by private vehicle

3.2.1
Gamification

Gamification uses elements of game design, such as scores, leaderboards, badges, levels, and rewards, in non-game contexts to incentivise, engage, and nudge towards desirable actions (Vanolo, 2018). Its successful applications can be seen in apps such as TikTok, Duolingo, or Forest. TikTok incorporates both extrinsic rewards (i.e., rewards as number of likes or followers) and intrinsic rewards (i.e., motivating the user to master build an audience and the feedback loop that is provided through likes and followers) (Vanolo, 2018).

In a mobility setting, the intended behavioural changes can be about changing transportation mode and time. Gamification for transportation can employ a combination of nudges such as simplification and disclosure of information, defaults, and provision of travel history, as well as increase ease of use and convenience. The MotionTag app acts as a mobility log book by providing an overview of personal travel statistics and enabling the comparison of statistics with other users to determine the degree of environmental friendliness of travels in terms of carbon footprints[1], for example. Singapore's smart commuting programme encouraged travellers to shift their transit time to off-peak hours to win rewards (Land Transport Authority of Singapore, 2015). Another successful case was

the Infosys-Stanford Traffic Project (Merugu, Prabhakar, & Rama, 2009) that rewarded travellers with points for travelling during off-peak hours and drew them into a prize draw at the end of every week (see case number 2 in Appendix 1). However, whilst this gamification-oriented incentive strategy was found to be effective in the aforementioned cases in reducing congestion in the peak hours and benefitting the entire system, the challenge is designing the intervention in a way that understands the values of citizens so as to encourage participation, as contextual, geographical, and cultures aspects vary greatly (Ortmann & Dixit, 2017).

Measurements such as charts, points, and badges assign a position to each user, transforming them into assessable units, which removes the human aspect and can also form a hierarchical social structure within the group of users. Furthermore, it is argued that gamification of what is an appropriate behaviour runs the risk of solutionism – the belief that every problem has a solution based on technology – that the right app with the right system of feedback and rewards may make it possible to nudge behaviour and fix problems without a radical rethinking of the system (Vanolo, 2018).

3.2.2
Incentives

This strategy is about using incentives or discounts to encourage travellers to shift their transit mode to public transport, cycling, or walking. The most common practices include reducing fares, offering discounts for travel during off-peak hours for frequent commuters, or provision of convenient payment systems, such as the T-Money app in Seoul, South Korea. Although incentive strategies do not fall under the nudge interventions defined by Thaler and Sunstein (2008), findings from case studies show that they can have a robust impact. Hong Kong's Mass Transit Railway authority offered pre-peak hour commuting discount fares to reduce overcrowding and congestion in stations (Halvorsen, 2016). Similarly, Metropia provides incentives in the form of reward points towards gift cards for more sustainable transportation choices (Movin'On Lab , 2019).

Behavioural changes from incentives can result in changes in congestion reduction, transit mode, departure time, and reduction in car trips. As commuters stand to gain from these practices, they tend to be widely accepted. Encouraging people to use public transportation and non-private vehicles can assist non-drivers while also improving affordability and mobility. The resulting changes may lower demand for car use and alleviate congestion for car owners, who benefit from the

incentives as well (Ortmann & Dixit, 2017). However, a criticism of financial-based incentives could be that it may not result in long-lasting behavioural change and the commuter may only be using a certain mode of transport in order to get the financial incentive. Thus, the incentive may only help to reduce the frequency of a certain behaviour (e.g., slow peak congestion) rather than resulting in the formation of new habits (Halvorsen, 2016). Commuters would also respond differently to the same incentive depending on how regularly they use transport services and how time-sensitive or cost-sensitive they are. Thus, incentives may be better received if they are personalised to convey the specific benefits that will be realised for the individual. Furthermore, financial incentives may not be economically sustainable for transport operators. This may be particularly true for micro mobility services operators as they may have less financial capability to provide such incentives for an extended period of time compared to public transport operators.

3.2.3
Defaults

People often choose pre-configured options that are set as 'default' for them as they make the process of decision making easier and faster. Defaults can be presented in different ways – as one default set for several options or as a forced choice deafult where the individual has to choose before receiving a service and/or product. Default biases can be attributed to uncertainty about alternative options, biased perceptions, or congnitive limitations to simplify the decision making process. Default strategies can increase enrolment in programmes, such as in the case of Spain automatically enrolling its citizen for organ donation (Ortmann & Dixit, 2017).

Setting defaults in route-planning apps' decision architecture can help to encourage users to choose sustainable alternatives. By structuring the set of choices and presenting environmentally friendly options first while grouping alternative options by mode of transport, users can easily identify the environmentally friendly options, compare the alternatives, and understand the differences in attributes such as travel time and CO2 emissions. Moreover, as route-finding apps provide numerous alternatives, a personalised filtering functionality can reduce the cognitive load of reviewing all of them in order to choose the optimal route (Bothos, Prost, Schrammel, Roderer, & Mentzas, 2014).

TripGo2, a muti-modal trip planning app, provides emission information on each of the suggested travel routes. Such strategies can make commuters more environmetally conscious and shift behaviours from the usual default choice to more sustainable choices such as riding a bicycle or electric scooter. Similarly, the City Mapper3 app provides information on calorie usage and awareness of the benefits of walking more (cases 5 and 6 in Appendix 1). Individuals' dependence on defaults and habits is a source of travel pattern persistence. Periods of transportation disruption, on the other hand, provide an opportunity to remedy it. A study by Larcom, Rauch, and Willems (2017) discovered that disruptions in London's underground tube drove commuters to seek out more efficient routes, which they continued to use even after services were restored. Nudges that use gamification or utilise disruptions could assist people in exploring more desirable alternatives. For the alternative to have a long-term influence, it must deliver concrete value to individuals when compared to their previous default choices (Ortmann & Dixit, 2017).

When 'designing defaults, it is important to move beyond designing the right decision to designing for the right decision' (Harries, 2018). In other words, the user needs to trust the service operator to feel comfortable about the choice set being presented to them, otherwise they are less likely to follow the default choice. Thus, it might be beneficial to divulge information regarding the reasoning for the ranking of defaults. For instance, this could be done by the database the ranking were extracted from. Making any decision involves effort and incurs transaction costs. If defaults are used as a signal to inform the user about something, it allows the individual to form a preference without having to put additional efforts into making a choice (Harries, 2018).

People often choose pre-configured options that are set as 'default' for them as they make the process of decision making easier and faster.
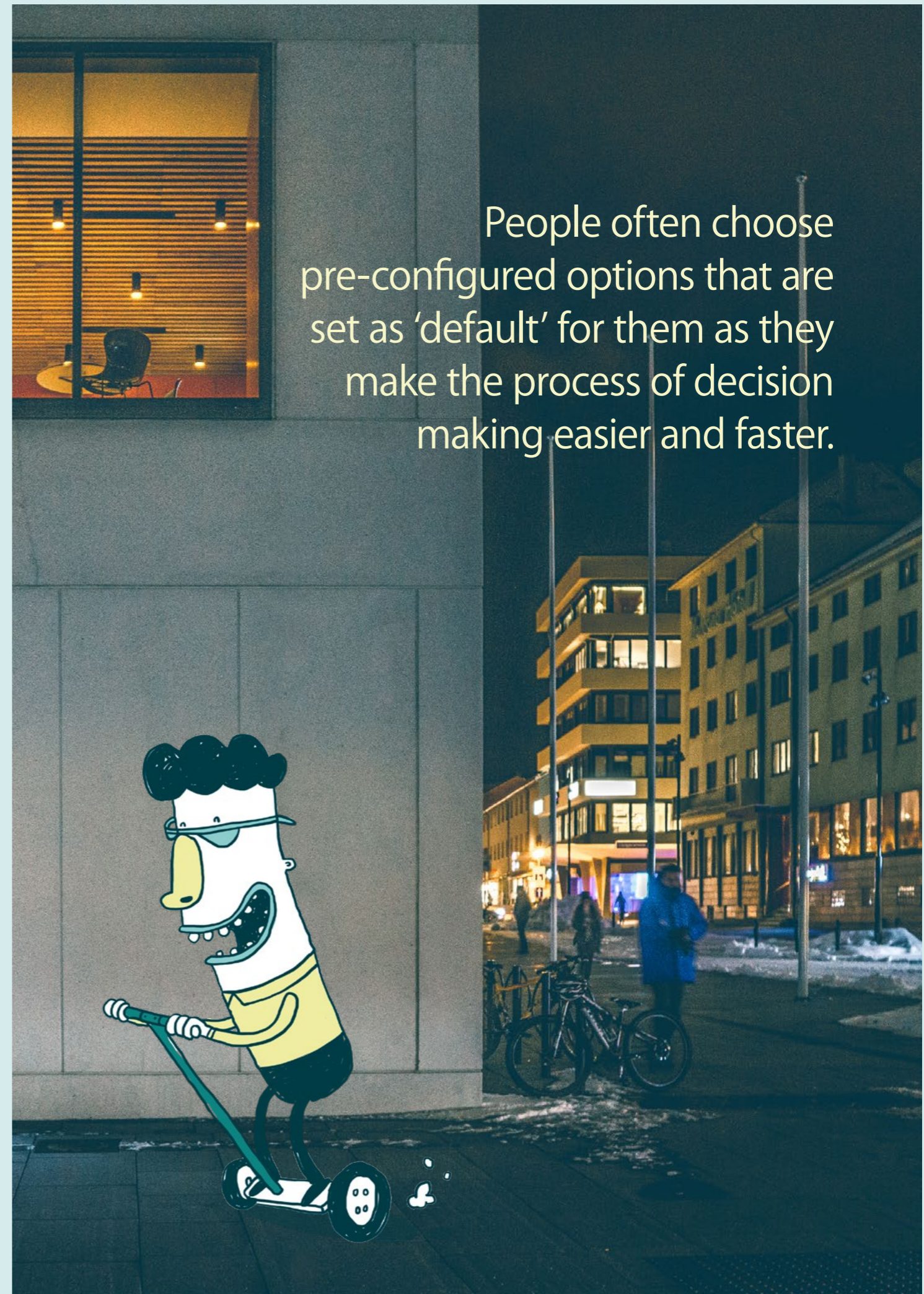
3.2.4
Perceptions: What You See Matters

Perceptions are shaped by the way our senses receive and process signals. They shape our view of the world and influence our choices (Ware, 2008 in Ortman & Dixit, 2017). Cognitive biases such as loss aversion, default biases, and perceptions can influence mobility decisions and subsequently impact other elements such as road traffic. Using this insight to frame decisions could help influence behaviour (Ortmann & Dixit, 2017).

Individuals tend to underestimate their travel time, which can have an impact on the choice of routes they choose to take as well as the mode of transport. Thus, designing interventions that can influence these perceptions to be more realistic could be beneficial (Dixit, Jian, Hassan, & Robson , 2019). It is equally important to note the influence of preferences and risk perceptions over a person's travel behaviour such as transport mode, routes taken, and travel time. This is captured in terms of the reliability value: how reliable are public transport services when we are asking individuals to change their travel habits? Ortmann and Dixit (2017) argue that there has been relatively limited work done to provide clear reliability indicators to commuters in order to influence travel decisions or provide guaranteed transportation services. This is becoming more complicated and more challenging to do as cities are working to nudge commuters towards inter-modal travelling and using more environmentally friendly alternatives. Car sharing fleet operators, for instance, might face the issue of lack of physical spaces for parking and responding to growing demand if people have more incentives to rent rather than to own cars.

People's behaviour can differ depending on whether information is framed as a loss or a gain, as people are particularly sensitive to losses. Thus, framing information or messages in a way that may make an alternative option more enticing is one strategy to encourage a shift in behaviour. A MaaS app can use this nudge by showing the economic costs (in terms of expenses or amount saved) and environmental costs (in terms of generated or saved CO_2 emissions) of using private vehicles and public transportation. An example of framing in gains is Singapore's Travel Authority's Travel-Free Morning Programme, which aimed to reduce morning cogestion during rush hour (8–9 am) by nudging commuters to travel earlier during pre-peak hour (7–8 am) for free or discounted rides and breakfast vouchers. Although data showed a 7% shift of commuters to pre-peak hour, strictly speaking the strategy cannot be classed as a pure nudge as it involves a financial incentive, i.e., a free ride. Furthermore, it is unclear whether the campaign resulted in long-term behavioural shifts and which types of commuters the campaign had the most impact on (e.g., frequnr commuters, monthly commuters, etc.). However, it is a good representation of the mix of pricing and non-pricing strategies where the effectiveness of the gain (i.e., breakfast voucher) is difficult to disentangle from the effects of the pricing intervention.

3.2.5
Framing and Presentation of Information

Illustrating travel information in a simple, visual, and easy-to-understand way is another strategy for influencing perceptions. The intention here is to encourage a shift in travel mode and multi-modal mobility, to reduce travel time, and to provide comprehensive information for trip planning, real-time travel, travel costs, and payment options. This is being increasingly utilised in Mobility-as-a-service (MaaS) and public transport apps that provide a one-stop-shop for all of a person's mobility needs. The Opal card[6] for the Greater Sydney area, for instance, uses an integrated fare system for public transport (bus, train, ferry, light rail) that makes it look like one mode of transportation is being used without having to worry about getting tickets or switching from bus to train. Other operators such as Skedgo or Jelbi offer personalised trip planning by bundling various transit options, payments, and parking for micro mobility vehicles. Berlin's Jelbi app[7] combines public transport and mobility sharing services in one app, making it easier for commuters to make the trade-off between private or public transport modes. The app currently has twenty partners (including public and private operators) offering a range of services: e-scooter, e-moped, bike, car, taxi, public transport, and ridesharing.

Designing or changing the physical environment is one of the most commonly used forms of nudge interventions that utilises visualisations to influence perceptions. For example, smart speed radar displays in Dubai catch the driver's attention by displaying speed with a happy or sad face emoji[8]. It is important to note that nudge interventions of feedback, reminders, simplification of information, and use of graphics also play a role here. Similarly, as part of its Cycling Path Network infrastructural upgrade, Singapore has set up bicycle wheeling ramps along stairs to helps cyclists navigate the city more easily[9].

It is important to pay attention to the way information is designed and presented to the user so as to avoid the unitended consequences of what Wijayaratna, Dixit, Laurent Denant-Boemon, and Waller (2017) call the information paradox. Their study found that providing real-time traffic information to users on certain routes made congestion worse and increased economic costs for transport operators and users as well as time spent in traffic, as users took the recommended route, anticipating shorter travel time and costs. Thus, the type of information displayed and recommended must be carefully planned and monitored. Perhaps a better way would have been to give an estimate of the percentage of commuters expected to take the specific route: '45% of commuters are looking at this route, too.'

Travel information displays, be it on apps, websites, or at stations/stops, ease access to the use of public transport networks and micro mobility. Clear and coherent maps and schedules, real-time traffic information, information on inter-modal transport connections (e.g., car sharing, e-scooters, bikes), information regarding connections to other lines or modes of transport, and information depicting the most sustainable way of commuting will all make a difference. Environmental impacts and costs of trips with different transport modes can be offered as well, including the calculation of the cheapest and most sustainable way of travel. All information should be available in multiple formats in order to ensure that less technology-savvy people, people with special needs, and the elderly have access to the necessary information (Civitas, n.d.). One good example is Singapore's new Passenger Information Display System (PIDS) which at bus stops provides information on incoming buses, the quickest route to frequently visited destinations, messages (e.g., service delays, disruptions), and landmarks along each bus route such as hospitals[10].

[4]For more information, see: www.lta.gov.sg/content/ltagov/en/newsroom/2013/4/2/travel-early-travel-free-on-the-mrt.html

[5]https://www.lta.gov.sg/content/ltagov/en/newsroom/2014/5/2/extension-of-free-pre-peak-travel-by-one-year.html

[6] www.transportnsw.info/tickets-opal/opal#/login

[7] www.jelbi.de/en/home/

[8]See www.khaleejtimes.com/uae/emoji-traffic-alerts-for-motorists-near-dubai-schools

[9] See Land Transport Authority of Singapore: www.lta.gov.sg/content/ltagov/en/getting_around/active_mobility/walking_cycling_infrastructure/cycling.html

[10]For more information, see www.lta.gov.sg/content/ltagov/en/newsroom/2021/9/news-releases/New_PIDS_at_more_than_300_bus_stops.html

4.
Mobility Practices Around the World: Nudges

Urban life encompasses the lives and experiences of people in cities. That being said, no two cities are alike and the mobility solutions developed and implemented will vary. The aim of this section is to document the nudge interventions that have been implemented in the transportation systems of cities around the world. The following examples were chosen based on the availability of data, transportation system characterisitics, and novelty of solutions.

People's mobility decisions and behaviours can greatly impact congestion, pollution, traffic time, and commuting costs.

4.1
Singapore

Singapore is repeatedly cited as one of the top-ranking cities for a public transport system that is convenient, accessible, affordable, sustainable, and efficient.

- **Nudge:** Changes to the physical environment: One distinctive feature that sets its transport system apart is the changes it has implemented in its physical environment to make it more convenient for commuters. [11] Singapore's weather has abundant rainfall and high humidity due to its close proximity to the earth's equator. As a solution, the city built sheltered walkways and skybridges that connect public transport networks to residential, school, and commercial areas to make access to stations and stops more convenient (Figure 1).

Figure 1: Singapore – Sheltered walkways

- Silver zones in residential areas enhance road safety for the elderly (Figure 2) while the 'Green Man plus' placed at pedestrian crossings at traffic signals extend the length of time for pedestrians to cross when they tap their transit cards (Figure 3).

- Connected cycling path networks include bicycle wheeling maps along stairs, dedicated bicycle parking, lanes, and street crossings, and safety markings at bus stops with 'slow' markings and speed reduction strips (Figure 4).

Figure 2: Singapore – Silver zones for elderly

Figure 3. Singapore – Green Man plus at pedestrian crossings

[11] For more information, see www.lta.gov.sg/content/ltagov/en/getting_around.html#public_transport

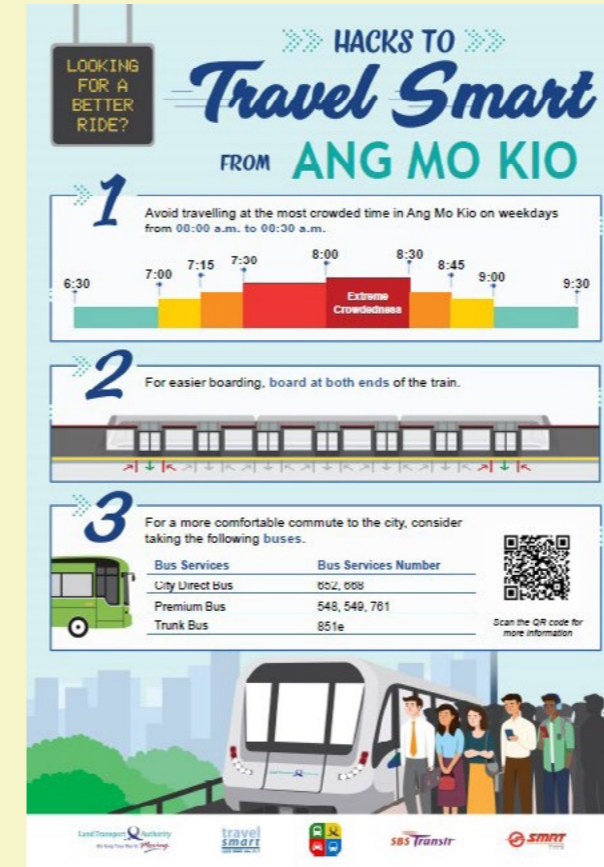Figure 4: Singapore – Cycling Path Network

Figure 4: (Left) Information simplification at bus stops, (Right) new information display

- **Nudge: Simplification:** Location-specific information has been placed at bus stops receiving the most passenger traffic to enable the commuters to make more informed choices and improve their commuting experience[13]. The new passenger information displays at bus stops provide information on incoming buses, the quickest route to frequently visited destinations, messages (e.g., service delays, disruptions), and importants landmarks along bus routes[14].

- **Nudge:** Convenience: SimplyGo[15] is the integrated fare payment system. Commuters no longer need to carry a separate travel card or make upfront ticket payments, as all their commuting fares will be charged and billed to the account connected to the app. Additionally, fare expenditure and travel history can also be viewed in the app.

- **Incetives:** Travel Smart Journeys (TSJ)[16] was introduced to help distribute peak-hour passenger traffic on public transport by encouraging commuters to adopt alternative modes of travel. Commuters earn 150 points per trip (equivalent to $1.50) if they travel between 7–9 am on weekdays. By participating consistently, the collected points would cover at minimum half of the bus fares. There is also the option of converting 500 points to a $5 reward in the travel accounts.

- **Nudge: Social norm:** The Travel Smart Network[17] encourages companies to adopt flexible working hours, use alternative transit modes, and build facilities that make using micro mobility (e.g., biking) easier and more convenient. As of 2018, the network consisted of 220 organisations and 36,000 employees. Employees from organisations that are part of the Travel Smart Network can earn more points under the TSR, which they can then exchange for cash rewards.

[12] www.lta.gov.sg/content/ltagov/en/getting_around/active_mobility/walking_cycling_infrastructure/walking.html
[13] www.lta.gov.sg/content/ltagov/en/newsroom/2018/7/2/factsheet-commuters-can-travel-smarter-with-travel-smart-information.html
[14] www.lta.gov.sg/content/ltagov/en/newsroom/2021/9/news-releases/New_PIDS_at_more_than_300_bus_stops.html

[15] www.simplygo.transitlink.com.sg/
[16] www.simplygo.transitlink.com.sg/TSJ
[17] www.lta.gov.sg/content/ltagov/en/newsroom/2018/7/2/factsheet-commuters-can-travel-smarter-with-travel-smart-information.html

4.2
Dubai, United Arab Emirates

Dubai is one of the most advanced metropolitan cities in the Middle East. Its mobility infrastructure is continuously improving as the city makes investments towards a more sustainable and smart transport system. The city has implemented smart mobility solutions to address congestion issues as most residents use private cars for reasons of vehicle affordability, hot climate, and convenience (Deloitte, 2020). Some of the solutions implemented are described below:

• **Nudge: Physical environment:** Taking into account humidity and hot temperatures prevailing throughout most of the year, Dubai Road and Transport Authority (RTA) has rolled out new bus shelters in busy locations across the city with plans for the construction of 1,550 additional shelters in the next four years. The shelters come in four different styles with a canpoy for shading, air conditioning inside the bus stops, wheelchair accessibility, tactile ground surface indicators for the visually challenged, information display boards, ticket purchase machines, and bike racks.[18]

• **Nudge: Convenience:** S'Hail MaaS app brings journey planning with various transport modes and payment under one place. Some notable features are travel account top-up, e-hailing services bookings, travel reminders, real-time moving information of the transport network, and the ability to view public transport maps both online and offline.[19]
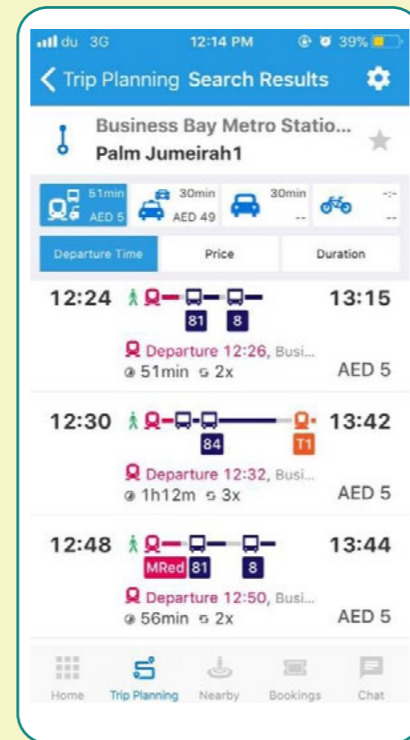

Figure 5: S'Hail MaaS app

Figure 5: New bus shelters

[18] www.whatson.ae/2020/06/these-new-generation-bus-shelters-will-soon-spring-up-all-across-the-city/
[19] www.gulfnews.com/lifestyle/rta-app-shail-helps-plan-your-travel-in-dubai-1.2116065

4.3
Seoul, South Korea

With a population of 10 million, Seoul is one of the most congested cities in the world (Worldometer, n.d.). It has one of the most extensive, integrated, and complex public transport systems and is one of the highest-ranked cities in terms of ease of use, convenience, accessibility, and efficiency (McKinsey , 2018).

• **Nudge: Convenience:** The T-Money app is perhaps the most different MaaS app compared to its counterparts in other regions in terms of the services it provides, as it takes a departure from the usual services provided by such apps. The app operates in 6 metropolitan cities and can be used for bus, subway, and taxi services, and offers mileage benefits and transfer discounts (if occurred under 30 minutes). The app can also be used to make payments at convenience stores, museums, purchases at venues, university cantines, vending machines, entrances to stadiums, cinemas, parking stations, and automatic terminals, as well as offline and online affiliated stores. [20]

• The physical travel cards also come in a variety of designs with various anime characters (e.g., Pokemon), which sets it apart from other transport operators. Any form of personal possession is an extension of the self and a way of communicating about who the person is to others. Understanding trends and cultural nuisances and incorporating them into the mobility offerings is one way of enticing customers, which has been supported by studies (Franssens, Botchway, de Swart, & Dewitte, 2021). Another interesting supplementary offering is the sticker card, which can be placed on the back of one's phone when making payments.
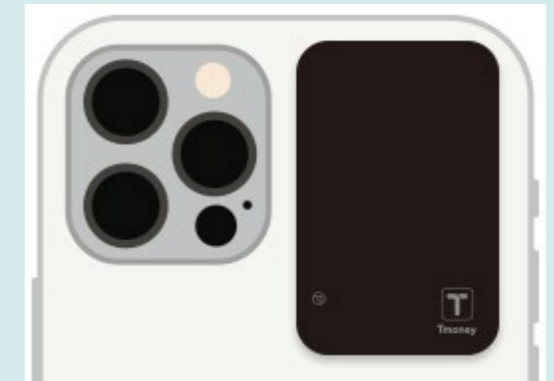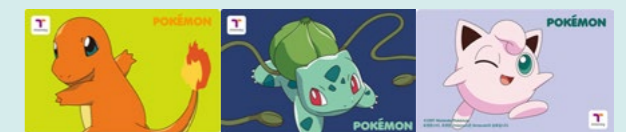

Figure 6: T-Money Physical cards

Figure 6: (Top) T-Money Physical cards, (Bottom), T-Money Mobile app and T-Money sticker

[20] www.eng.tmoney.co.kr/en/aeb/main/main/readMain.dev

4.4
Europe

4.4.1
Cycle Superhighways – Copenhagen, Denmark

Nudge: Physical environment and graphics: Copenhagen's robust bike culture is already well known across the world. It intends to encourage more riding and improve the convenience and accessibility of bicycle networks with the cycle superhighways. These superhighways may be identified by their location and physical characteristics, which link work, educational, and residential neighbourhoods to the city centre, railway stations, and public transportation to form continuous routes. In order to improve the riding experience, amenities such as motion-sensing LED lights, air pump service stations, and 'green wave' technology (coordinate traffic lights for smooth flow of biking so that cyclists have green lights at traffic signals during the morning peak hour) have been implemented throughout the route (Centre for Liveable Cities, n.d.)

4.4.2
Berlin, Germany

Nudge: Convenience: The Jelbi MaaS app combines route planning, reservation, and payment for all mobility services offered in the Berlin area. It offers 12 types of public transport and shared mobility services for travelling, such as rental bikes, scooters, taxis, and e-scooters[21]. This is another example of a combination of several nudges in an online setting, including simplication of information, increasing ease and covenience of services, and disclosure of available and comprehensible information.

4.4.3
Switzerland

The fairtiq app aims to create a seamless experience for public transport ticket purchase on journeys for bus, boat, tram, and train. Commuters do not need to specify the starting point or destination, buy a ticket in advance, or struggle to find the right transport zone. Once logged in, the app calculates the best available fare for the journey regardless of trip duration or line changes. The app also has a smart stop feature that detects when the commuter has left the vehicle and forgotten to end the journey by starting a countdown to check the user out.

[21]www.jelbi.de/en/home/
[22]www.fairtiq.com/en-ch/passengers/how-it-works

Individuals tend to underestimate their travel time, which can have an impact on the choice of routes they choose to take as well as the mode of transport.
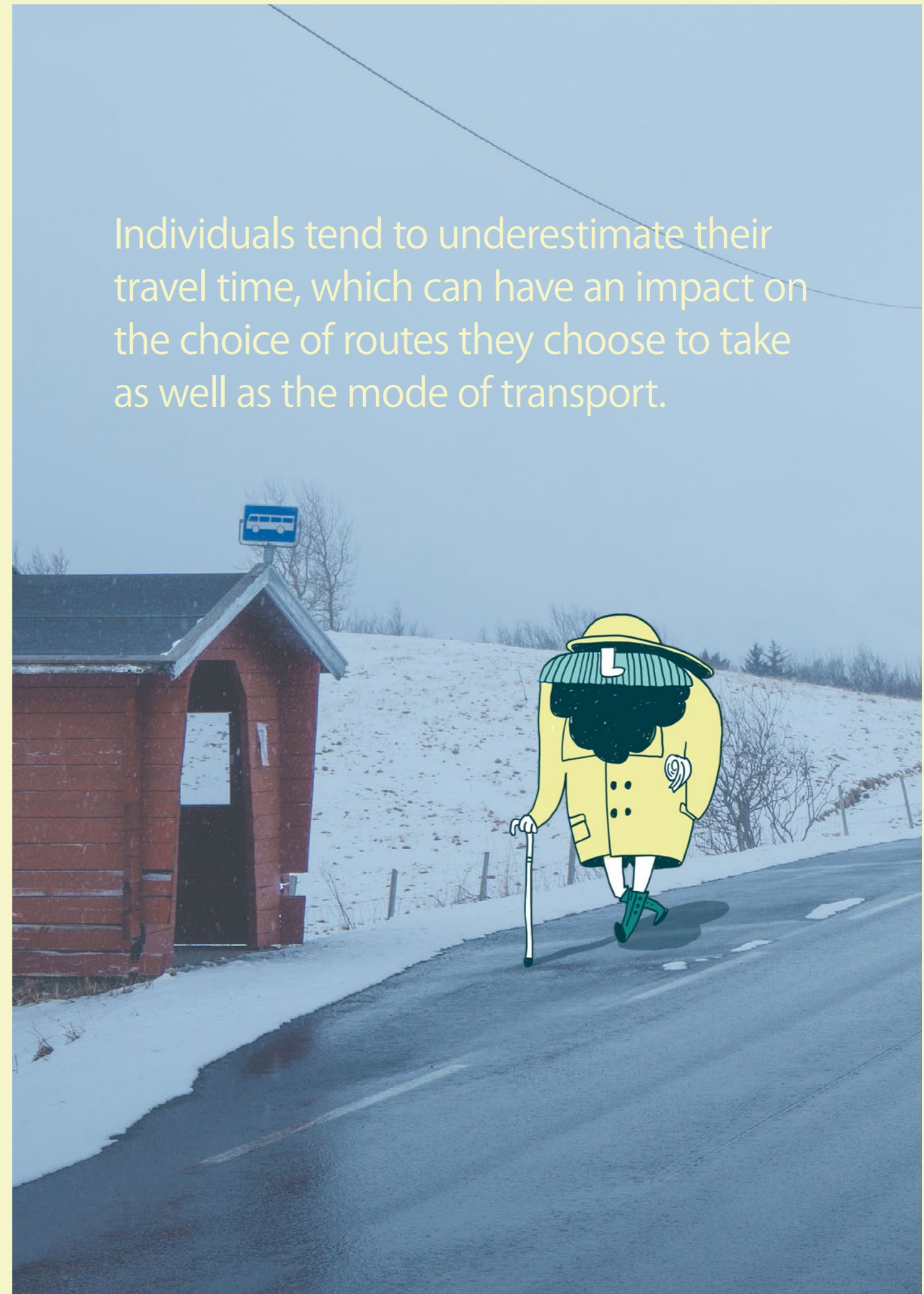
5.
# Concluding Remarks: What Has Been Learned?

The purpose of this report was to explore the application of various nudge interventions and their effects in the transportation and mobility sector from academic research, practice-based reports, and practical applications implemented in various regions. The observations deduced are as follows:

- The purpose of this report was to explore the application of various nudge interventions and their effects in the transportation and mobility sector from academic research, practice-based reports, and practical applications implemented in various regions. The observations deduced are as follows:

- There is a lack of detailed information on the way nudge programmes were implemented or inadequate progress updates or findings (Movin'On Lab , 2019). Pilots or programmes that were implemented often lacked reports detailing their findings and impacts. Others (Ortmann & Dixit, 2017) have also observed that there is a bias towards reporting positive findings, which must be considered when evaluating the impacts of a specific nudge.

- The design of the nudge strategies from practical examples were not clearly documented, with most research studies lasting for only a short period of time (Halvorsen, 2016; Maca, Scasny, Zvěřinová, Jakob, & Hrnčíř, 2020).

- Most of the nudge interventions seemed to be general and failed to consider the target groups that were asked to make behavioural changes. However, examples from Singapore, Dubai, and Seoul were more based on local transport conditions and considered the local context. Transport planners would benefit from understanding the local culture and commuters' wants and needs and incorporating them into their strategies. Seoul's T-Money travel card design is a good example of this, as the cards use anime characters that are already familiar to the citizens (i.e., using these characters as emojis in messages) to nudge people into having a more positive perception of and attitude towards using public transportation. In other words, perceptions do matter.

- Nudges are usually implemented in conjunction with other service improvements, so it is difficult to disentangle the impact of a specific nudge as in most cases several interventions are carried out at the same time. This was clearly evident in nudge strategies implemented in Singapore, for instance. Furthermore, it is difficult to ascertain the robustness of findings from academic studies as most of the trials were carried out for too short a period of time (Namazu, Zhao, & Dowlatabadi, 2018; Franssens, Botchway, de Swart, & Dewitte, 2021).

- Alternative options may sometimes be more beneficial to commuters but may be ignored due to perceptions and cognitive biases. People might be nudged to move to alternatives if the framing of the message/information is done in a way that alleviates a need. Incentives can be introduced if the alternative by itself does not provide value to the individual. Indeed, the results of studies that incorporated incentives (mostly financial) showed it to be effective, even though a financial incentive cannot be technically classed as a nudge (Thaler & Sunstein, 2008; Halvorsen, 2016).

- Gamification can be thought of as an incentive or information-based nudge intervention in that it serves as a catalyst. However, people are likely to cease their present travel habits and form new ones if they feel they are better off than before. Aside from in research studies, examples of gamification used as a nudge were less commonly applied by mobility operators compared to other nudges (e.g., information provision, change of physical environment). The cases that did use this type of intervention, such as the MotionTag app, mostly incorporated the scoreboards element of gamification. The under-usage of this intervention could be due to back-office technical requirements, the strategy required to engage different users, or the continous need for updating the games to keep users interested.

- Travel time and costs are major considerations affecting mode of transport. City planners should pay attention to the connectivity of the transport network as a whole by speeding up services or increasing intermodality by placing alternative transport modes (e.g., bikes, scooters) next to bus stops or ferry stations, for instance.

Effecting changes in behaviour requires more than just implementation of nudges. Transport and mobility operators should expand and build on the current transport infrastructure by improving services (e.g., integrated travel cards and integrated payments, tickets with varying time limits and for different customer categories), increasing intermodal commuting through the strategic placement of micro mobility vehicles, enhancing the physical environment (information displays, parking), introducing incentives, and visual designs that take into account the local context. Accompanying measures could be similar to those introduced in Singapore and Seoul through price discounts or by incentivising early arrival, which can be undertaken in collaboration with business organisations. Another area of interest could be trialling park-and-ride services by placing bikes/e-scooters near areas receiving heavy pedestrian and car flow or encouraging businesses to improve or build facilities that promote the use of alternative modes of transport.

There are two points to be made here. First, data should be utilised to learn about each user's travel patterns and to provide information at as many touchpoints in as visible a way as possible to make content clear and relevant to the individual. Second, in order to have any long-lasting, sustainable benefits, convenience, ease of access, availability, and price must constantly be addressed for each service and for the system as a whole.
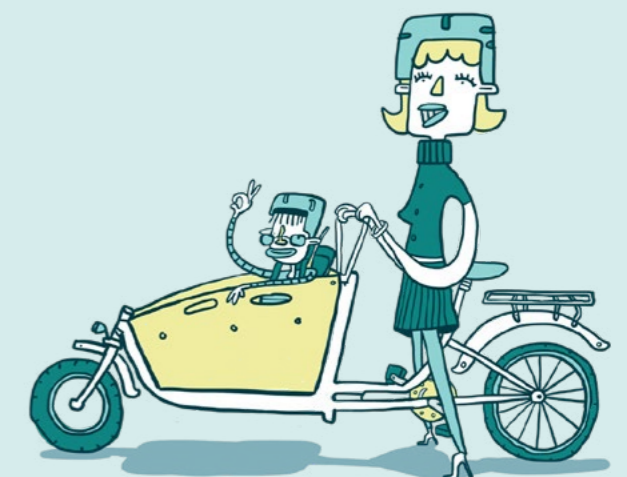
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Overview of Nudge Research and Practices from Around the World

	Cases	Nudge mechanism	Description	Intended behavioural changes	Impact
1	Land Transport Authority of Singapore	Gamification, incentives	Shift transit time to off-peak hours to win rewards	Shift trip time	Daily average of up to 10,000 commuters shifting out of the one-hour peak between 8 and 9 am, equivalent to 6–7 trainloads of passengers
2	Infosys-Stanford Bangalore, India	Incentives (positive pricing)	Travellers received credits for swiping in at work either before 8 am (1.5 credits) or between 8 and 8:30 am (1 credit). At the end of each week participants with at least 3 credits participated in a draw to select winners who received cash.	Shift trip time	Over the six months of the experiment, the number of bus commuters who arrive before 9 am increased by almost 30%.
3	Mass Transit Railway Hong Kong, China	Incentives	25% discount on pre-peak hour commuting fares	Shift trip time	Over nine months of the experiment, morning rush hour ridership reduced by 3%
4	Metropia app US cities (Austin, El Paso, Tucson, New York City)	Incentives, rewards	Navigation app showing optimal departure and arrival times. It gives reward points to use toward gift cards for drivers who plan trips in advance. Drivers get more reward points by carpooling. After the end of each trip, the app shows the number of emissions as well.	Shift trip time Make drivers environmentally conscious	Data not available
5	Skedgo and its subsidiary TripGo	Defaults	Personalised trip planning by bundling payment options for various modes. Uber Australia partnered with Skedgo to complement its ridesharing trips with public transport routes. The app also shows the amount of emissions by taking each option.	Look for alternative travel mode options and make drivers environmentally conscious	Data not available
6	City Mapper	Defaults	Journey planning service integrating data for all urban modes of transport, from walking and cycling to driving. Present in 31 European cities. City Mapper Pass offers subscription on mobility services in London	Search for alternative travel mode options	Not available The app has approximately 137,000 downloads and an average rating of 4.8 stars on Google Play
7	Incentivising cycling in the Czech Republic	Gamification, financial rewards	To increase cycling in the Czech Republic among regular commuters, 'cyclers' app was used with 4 different motivational nudges (smart gamification, two variants of a financial reward, and a combination of smart gamification and a financial reward) or a control group (no specific motivation)	Encourage cycling	People can be effectively motivated to engage in more frequent commuter cycling with incentives via a smartphone app. Offering small financial rewards seems to be more effective than smart gamification. A combination of both motivational treatments – smart gamification and financial rewards – may work in the same way or slightly better than financial rewards alone.
8	Nudging commuters to increase public transport use in Rotterdam	Incentives, rewards	Navigation app showing optimal departure and arrival times. It gives reward points to use toward gift cards for drivers who plan trips in advance. Drivers get more reward points by carpooling. After the end of each trip, the app shows the number of emissions as well.	Shift transit mode	Number of riders per hour was 1.18 rides per day more on the experimental lines than on the control lines. This shows that public transport operators can increase public transport use by incorporating messages that positively label passengers as sustainable travellers in their communication strategies
9	Nudging for car sharing	Reminders	The study used reminder cards to nudge car sharing users to inspect the car before using it	Inspect vehicle before usage	2 weeks prior to the end of the study, the inspection increased even without the presence of the card.
10	Jelbi MaaS app Berlin, Germany	Simplification, disclosure, ease, and convenience	Combine route planning, reservation, and payment for all mobility services offered in the Berlin area	Increase inter-modal commuting	Data not available
11	Fairtiq app, Switzerland	Simplification, ease, and convenience	Seamless experience for public transport ticket purchase on journeys for bus, boat, tram, and train	Increase public transport commuting	Data not available
12	Cycle Super-highways Copenhagen, Denmark	Change in physical environment, ease, and convenience	To encourage more cycling and increase the ease and accessibility of cycling networks	Increase bike commuting	23% increase in the number of cyclers on weekdays
13	T-Money MaaS app Seoul, South Korea	Simplification, ease and convenience, disclosure	Can be used for bus, subway, and taxi services, to make payments at convenience stores, entertainment places, offline and online affiliated marketplaces	Increase public transport commuting	Data not available
14	Nudging commuters to increase public transport use in Dubai, United Arab Emirates	Change in physical environment, ease and convenience, disclosure	Bus shelters with air conditioning, bike racks, ticket machines	Increase public transport commuting	Data not available
15	S'Hail MaaS app Dubai, United Arab Emirates	Simplification, ease, and convenience	Travel account top-up, e-hailing services bookings, travel reminders, real-time moving information of transport network and viewing public transport maps	Increase public transport usage and inter-modal commuting	Data not available