Nudging sustainable behaviour: Data-based nudges for smart city innovations

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Abstract: This contribution deals with the challenge of promoting the awareness and use of new city innovations enabling a smart sustainable lifestyle. Nowadays there is a gap between smart city pragmatic users (early majority), because we are facing a special challenge in the phase of innovation scaling. The free use of city innovations that promote a sustainable lifestyle is very often linked to changes in behavioural routines (e.g. bicycle use instead of car use; regional consumption vs. online purchase). In this paper we investigate the benefits and limitations of social comparison theory and similar behavioral approaches in designing incentives and stimulus mechanisms for a new digital platform and mobile application for intelligent urban innovation. Based on an intensive state of art literature review and a best practise analysis, we propose a specific digitally supported intervention design to encourage citizens to use smart urban innovation in their local environment. The design will then be tested and evaluated in two European Smart Cities as part of an EU research project: www.simplicity-project.eu. We will discuss the potentials and limits of an ethical nudging approach and important implications for evaluating effects and impacts thereof.

Keywords: Data-based nudging; behavioural innovation insights; target-group specific nudging methods; behavioural change for adoption of smart city innovations.

1   Introduction and background

The increasing impact of climate change and the urgency of taking effective action is becoming a priority issue for countries and cities. Practitioners, governments and policy makers are facing new challenges on how to integrate the United Nations Sustainable Development Goals (SDGs) in their policy agenda and manage a complex system of stakeholders. In order to address these challenges, governments around the world have already launched multiple smart city initiatives focusing on the development of new digital, sensor-based applications, wireless networks or web- and mobile-based applications. New technologies enable citizens to live a more sustainable life, which aims at living in a way that lowers the individual carbon footprint and supports local consumption and civic engagement (see e.g. Harter et al, 2010; Cohen, 2017). The aim of these information technologies is to trigger a change in consumer behaviour at urban level in dealing with local consumption and sustainable mobility through effective "choice architectures", often called in short "nudges".

This paper aims at discussing the relevance of approaches known from the vast field of behavioural science for designing such data-based interventions and digital nudges. First, we present the current project SimpliCITY (2018-2021, www.simplicity-project.eu) in which the two small-scale smart cities City of Salzburg (Austria) and City of Uppsala (Sweden) aim at scaling up regional sustainability services and increasing their visibility by means of a novel aggregated service platform and related web-application. The project will provide a proof of concept for a replicable online platform, which aggregates new smart city services and engages citizens through behavioural nudges and gamified features. It will focus on bike-mobility services, local production and consumption and social inclusion services and is developed with an intensive multi-stakeholder co-creation process (see Paraschivoiu I. et al., 2020 for description of the process and lessons learned). Secondly, we describe the scientific background for the project approach and give an overview of similar projects that served as best practice examples. Thirdly, we describe how we seek to measure results and lay out the experimental outline for one of the nudging methods that is based on social comparison in order to foster sustainable behaviour of citizens on a district level. Finally, we will discuss the limitations of designing such nudges and interventions strategies.

2   Expectations about nudging sustainable behaviour in smart cities

Co-creation approaches, user-centric design and the use of insights from behavioural economics are not fundamentally new within the field of persuasive computing and behavioural innovation. However, the goal of transforming a city into a sustainable smart city by focusing not only on new technologies, but above all on the lifestyle of its citizens adds a new level of complexity to existing strategies and innovation scaling methods. New technologies enable a wide range of data collection, but urban planners and policy makers would need methods to use this collected information for ethical nudging a sustainable lifestyle (Stamatiadis et al., 2017).

Insights from behavioural economics (e.g. Beck, 2014; Thaler, 2016; Thaler & Sunstein, 2009) have established itself across various sectors. With the growing interest in intervention mechanisms in a digital environment (Schneider et al., 2018), behavioural

economics is gaining interest for smart city managers. The increase in intensive and wide-ranging use of mobile devices and sensor technologies enables smart city managers to design the application of data-based approaches for intervention policies (Smets & Lievens, 2018). The advantage of using web-based applications as a tool for data-based interventions is many-fold. Web-based applications serve as a data gathering tool but they can also incorporate external data such as weather data, traffic data, data on emissions etc. The information gained from internal and external data helps to influence the decision-making process more precisely and to monitor the effect in terms of more sustainable decisions. Information about transport alternatives and rewards for the choice of sustainable means of transport such as bike mobility may influence behaviour in the desired way (Kormos et al., 2015). Similarly, information about consequences of certain decisions may lead to a desired change in behaviour (Allcott, 2011). The collected data may also be used for further interventions in form of social comparison and feedback. Information that contains decisions of others can influence people's behaviour significantly (Kormos et al., 2015; Allcott, 2011). The design of the choice architecture and the impact of digital and data-based intervention in a SC and sustainability context is still rare (Esmark, 2017). Especially in the transportation sector, the effectiveness and efficiency of instruments trying to change travel behaviour are little studied (Mont et al., 2014). Only recently, an emerging field of researchers is dealing with behavioural innovation (see: R&D Management Conference 2019), which deals with a multi- and cross disciplinary approach delving into innovation capabilities from companies and that is related to the fields of behavioural strategy, psychology and behavioural economics. However, hardly no research in this emerging field deals with aspects of supporting citizens in making sustainable data-based decisions.

For this reason, the project SimpliCITY was started. As explained above, the two small-scale cities of Salzburg, Austria and Uppsala, Sweden are trying to find effective intervention strategies in order to scale up and increase the visibility of regional sustainability services by means of a novel aggregated platform and web-application and to raise awareness and create a community through nudging by developing methods and tools for nudging a community for these services. The project will provide the proof of concept for a replicable online marketplace, which aggregates these services and engages citizens through behavioural nudges and gamified features. In order to increase the awareness and usage rate, the app, currently being developed with intensive co-creation of various stakeholders, will include different elements of gamification and nudging (cf. Paraschivoiu I. et al., 2020).

Gamification uses game design elements outside of games, for example, as rewards or challenges employed in an web-/mobile-based application. Gamification has been successfully used to keep citizens engaged in other smart city initiatives (Kazhamiakin, 2016). Gamification used in applications should motivate the users to engage more often with the application and lead to specific behaviours or behaviour changes (Engel, 2017; Hamari, Koivisto, Sarsa, 2014). Among the gamification elements in SimpliCITY are weekly challenges, learning activities and offers for district walking tours, in which citizens get to know the points of interest which provide information about smart city services (e.g. personal bike garages at train stations, mobile bike service stations, social repair cafes, urban gardening spaces, shared e-mobility infrastructures etc.). These gamification elements are dedicated to attract the citizens at a district level, in which users feel that they belong to their neighbourhood. The general challenge for citizens is

to participate in these activities, and for this purpose a system for collecting reward points (called "City Heartbeats") is planned to be implemented in the new city application (see Paraschivoiu I. et al. 2020, page 8, fig. 3 Mockups of the platform design).

3   Analysis of best practise cases in the realm of smart city initiatives using behavioural economic incentivisation instruments

Among other issues, the scientific questions of the research project deals with the challenge of effective design of a data-based nudge and choice architecture that could be embedded in the smart city app. In pursuit of this question an in-depth state-of-art analysis was carried out on insights from behavioural science for changing citizen behaviour, methods and tools for behaviour change, the nudging concept as well as its ethical evaluation for the project and a SWOT analysis for nudging in the context of smart cities and its citizens. A best-practice case study provides insights into the existing way in which research projects have dealt with the problem, analysing their potential and limitations.

Behavioural economy is a scientific discipline that uses psychological insights into human behaviour in order to explain economic relationships and the process of decision-making (Lourenco et al., 2016). Incentives play an important role within behavioural economics as they are described as an effective tool to change behaviour (McKenzie-Mohr & Schultz, 2015). The literature suggests a distinction between positive and negative influences (see e.g. Ly & Soman, 2013; Jochelson, 2007) as well as monetary and non-monetary incentives (see e.g. Buchan et al., 2000; Hall, 2009; Yavuz, 2004). Incentives can also be given by imposing regulations (see e.g. Ly & Soman, 2013; Hertog, 2010), providing information and building awareness (see e.g. Ly & Soman, 2013; Schans & Optekamp, 2016). Another important concept in behavioural economics is nudging, initiated by Thaler & Sunstein (2008). Basically, the concept describes how people can be steered in a particular direction without taking them the possibility of making their own decisions. Nudges influence behaviour by changing the way decisions are made. The literature on nudging is fast growing and quite voluminous by now (see e.g. Sunstein, 2014; Thorun et al., 2016; Mont et al., 2014; Meske, 2017). Recently, interest also centers on the use of digital nudges (see e.g. Meske & Potthoff, 2017; Schneider et al., 2018). In the context of smart citizen behaviour, a profound summary of behavioural change techniques can be found in Michie et al. (2013). For increasing citizens engagement and encouraging sustainable behaviour, gamification, which describes the use of game design elements in non-game contexts, has often been used as a method in smart city initiatives (see e.g. Kazhamiakin et al., 2016; Millonig et al., 2016; Cardoso et al., 2019). Ethical problems may arise if methods are designed in a non-transparent way and/or exploit psychological processes, meaning that they take advantage of non-reflected, quasi-automatic decision-making. For all methods used in SimpliCITY special attention is given to a reflective (cognitive) process and transparency. Display of results are either anonymised or based on informed consent.

Nudging methods propose various ways which can be employed to steer citizens towards decisions and behaviours that are deemed preferable for their wellbeing and society. However, apart from the strengths and opportunities of nudging there might also

arise weaknesses and threats. Based on Mont et al., 2014, our conducted SWOT analysis is summarized in table 1.

Table 1 SWOT analysis of nudging in SimpliCITY

Strengths	*Weaknesses*
• Governments can avoid legal regulation and instead use "soft" measures of nudging to influence people's decision-making and behaviour.	• Instead of tackling the deeper reasons of socio-economic and environmental issues (e.g. commercial strategies) governments try to reduce them with nudging.
• Relatively small cost of nudging, but often significant effects.	• Lack of decisive action of governments weakens their position and reduces citizen's trust in reliable governance.
• Nudges can provide citizens guidance regarding difficult decisions and behavioural changes.	• Experts doubt that nudging alone will solve critical health and environmental issues such obesity and climate change, for instance.
• Citizens can reject choices (opt-out) if they do not match with their preferences or perceive them not to be in their best interest.	• There is little evidence for long-term effects of nudges; repeated intervention will often be necessary to achieve significant results.
• Representative surveys confirm that a large majority of citizens approve of nudges if they are used appropriately.	

Opportunities	*Threats*
• Governmental agencies can strengthen trust in their conduct through transparent processes and involvement of citizens.	• Non-transparent nudging by public agencies might erode freedom of choice and values of a democratic society.
• Extension of the knowledge base of public bodies regarding societal issues and appropriate nudges by involving citizens, NGOs and other organizations.	• It can reduce citizen's acceptance and support of behaviour change policies.
• Web and mobile applications greatly expand the number of people that can be reached and involved as well as enable novel forms of nudging.	• It can also be unfair if in common good initiatives some can prevent being nudged and avoid costs but benefit from the gains.

Source: Pre-Study – Scientific framework: Methods and tools for incentivising the use of smart sustainability services. Project Deliverable 2.1: Stabauer P., Schrempf B., Bliem C., Geser G., Hornung-Prähauser V.

In order to identify best practices from research projects as well as city or business initiatives, the next step was to provide an analysis of research and living labs projects which have trialled and explored the use of various ICT-based incentivisation approaches. Regarding sustainable mobility and transport decision, web-based applications serve as an information or data gathering tool, a tracking device or reward system. Best practice case studies using ICT-based incentivisation approaches in the field of sustainable mobility include projects like Eco-Friendly Shopping Bags, Bike Citizens, Biklio, STREETLIFE, Cycling Kilometric Allowance, Sustainable Transportation Behaviour, Reduction of Electricity Consumption, Goodbag, Frequent Biking Challenge and the 10.000 Steps Challenge. Web-applications intended to promote local

consumption are often designed to focus on individual consumer needs as in SmartAPPetite. Addressing the aspect of social inclusion, digital platforms may be used for discussions, feedback, votings, surveys, information sharing etc. Various features were implemented in the projects CitizenLab, Implication Engage Barnet and Tribal Planet. The following table provides an overview of the type of intervention mechanism installed and trialled in various projects. The insights served as examples for furthering SimpliCITY.

Table 2 Overview of best practise using behavioural economics and ICT-based intervention mechanism

No	Project title	Type	Country	Field of application	Behavioural economics tools/methods	Digital
I	STREETLIFE[1]	Research application	Italy	(Bike) Mobility	Information, gamification, challenges	Yes
II	Cycling Kilometric Allowance[2]	Practical application	France	Bike mobility	Monetary incentives	No
III	Sustainable transportation behaviour[3]	Research application	Canada	Mobility	Descriptive social norm, information	Partly
IV	Frequent Biking Challenge[4]	Research application	Canada	Bike mobility	Triggering, social comparison, awareness	Yes
V	Bike Citizens[5]	Practical application	> 450 cities	Bike mobility	Information, monetary and non-monetary incentives, gamification	Yes
VI	Biklio[6]	Practical application	Portugal, Italy, UK, Sweden, Luxembourg, Bulgaria, Netherlands	Bike mobility	Information, monetary incentives, social norms	Yes
VII	10,000 Steps challenge[7]	Practical application	Singapore	Health	Challenge, gamification, monetary and	Yes

[1] https://cordis.europa.eu/project/rcn/110044/factsheet/en

[2] http://www.eltis.org/discover/case-studies/cycling-kilometric-allowance-france

[3] http://web.uvic.ca/~esplab/sites/default/files/Kormos%2C%20Gifford%20%26%20Brown%202015.pdf

[4] https://www.researchgate.net/publication/291351902_Challenged_to_Bike_Assessing_the_Potential_Impact_of_Gamified_Cycling_Initiatives

[5] https://www.bikecitizens.net/

[6] https://www.biklio.com/

[7] https://www.healthhub.sg/programmes/37/nsc

					non-monetary incentives, social norm	
VIII	SmartAPPetite[1]	Practical research & application	Canada	Local consumption	Information	Yes
IX	goodbag[2]	Practical application	Austria, UK, Portugal, Netherlands	Local consumption	Monetary and non-monetary incentives	No
X	Eco-friendly Shopping Bags[3]	Research application	Lebanon	Sustainable consumption	Reminders	Yes
XI	PIPs[4]	Practical application	USA	Social impact	Monetary and non-monetary incentives	Yes
XII	CitizenLab[5]	Practical application	Global	Civil engagement	Information	Yes
XIII	Engage Barnet[6]	Practical application	UK	Civil engagement	Information	Yes
XIV	Tribal Planet[7]	Practical application	USA	Social inclusion	Information, challenges, gamification	Yes
XV	Reduction of electricity consumption[8]	Practical application	USA	Electricity	Information, social norms, social comparison	No

Source: Pre-Study – Scientific framework: Methods and tools for incentivising the use of smart sustainability services. Project Deliverable 2.1: Stabauer P., Schrempf B., Bliem C., Geser G., Hornung-Prähauser V.

4 Measuring the effects

SimpliCITY focuses on bike mobility, local production and consumption and social inclusion, therefore, effects of the project on sustainable behaviour in these areas should be examined. Ajzen's (1991) theory of planned behaviour proposes that behaviour is influenced by various factors (e.g., attitudes). The theory of planned behaviour is commonly used in research around pro-environmental behaviour (Macovei, 2015). Factors like awareness and knowledge around a topic are usually seen as important factors before a change in behaviour occurs (see Ajzen, 1991 for further details), therefore, both awareness and knowledge as well as behaviour should be inspected.

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[1] http://theheal.ca/projects/smart-appetite/?fbclid=IwAR2PPNmP22nsqQisz40-zuZ4QTQUvdsJsk59DRrTxXTIMDDV2tRQxsoj7TE

[2] https://www.goodbag.io/

[3] https://nudgelebanon.org/2019/02/20/

[4] https://www.pipsrewards.com/login

[5] https://www.citizenlab.co/

[6] https://engage.barnet.gov.uk/

[7] https://www.tribalplanet.com/

[8] http://www.oracle.com/us/industries/utilities/social-norms-energy-conservation-3631977.pdf

Awareness and knowledge are concepts that are not always clearly defined or distinguished (see Trevethan, 2017, for a discussion). They can be defined as two ends of the same continuum, for example, McCallum and colleagues (2005) describe the lower end of the continuum as a general awareness and detailed and specific knowledge at the higher end of the continuum. The latter definition seems fitting for the goal of SimpliCITY: Users would move from being vaguely aware that some service providers exist (e.g., that there are second-hand stores) to having more specific knowledge about them (e.g., where the closest secondhand store is and what can be sold and bought there). After a change in attitudes and knowledge, a change in behaviour should also be investigated. For the evaluation of a possible effect of SimpliCITY on sustainable behaviour, self-reports of behaviour can be used. They are a common tool for investigating sustainable and pro-environmental behaviour, ranging from the use of single items to multi-item scales (see Lange & Dewitte, 2019). SimpliCITY can also use the tracked activity (i.e., kilometres biked or walked) generated by the application.

Further, apart from measures of awareness, knowledge and behaviour, the effects of nudging, particularly, social comparison as a nudge, will be investigated in an experiment which is described in the following section.

4.1 Using social comparison as nudging method

The concept of nudging is currently discussed in different scientific communities as well as by practitioners such as private and public organizations in order to achieve a desired behaviour of citizens (or customers). The concept of nudging describes how people can be steered in particular directions such as avoiding unhealthy food or reducing energy consumption, without taking them the possibility of their own choice. Based on insights from behavioural economics, that explain how behavioural changes are triggered by gentle incentives, nudges are used to influence people's behaviour without limiting choices (through commandments or prohibitions) or economic incentive systems (Ly & Soman, 2013). Nudging is seen as an instrument to promote behaviour that is beneficial for individuals or the society, and is mostly applied by policy makers to increase policy effectiveness or by companies for marketing campaigns or for influencing buying behaviour through in-store space layout and management (Mont et al., 2014).

Thaler and Sunstein (2009, p.6) give a demonstrative description of nudging and say that nudging is

> "any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic consequences. To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates. Putting fruit at eye level [to attract attention and hence increase likelihood of getting chosen] counts as a nudge. Banning junk food does not."

There are a number of methods for nudging available (see Sunstein, 2014). One interesting aspect for nudging sustainable behaviour in the project SimpliCITY is social comparison. Social comparison theory (Festinger, 1954) proposes a general human tendency to evaluate opinions and abilities (and further, behaviour) by comparing them to that of other people. This tendency has been also used to promote behaviour change: A meta-analysis (Abrahamse & Steg, 2013) showed that social influences can be beneficial in promoting individual changes towards more sustainable behaviour. For nudging,

following social comparison theory, one way to influence people's behaviour is to provide them with some information that their relevant social group is displaying a particular behaviour already. For example, a statement that most people in the neighborhood pay their electricity bill on time helps to improve timeliness of payments (see Nudge Lebanon, 2019). In addition, social comparison theory also states that our tendency to compare ourselves to others seems to become weaker as the other person's opinion or ability becomes more divergent from our own (Festinger, 1954). Similarly, the effect of using social comparison as a nudge seems to be stronger if there is a strong identification with the specific reference group (Doran, Hanss & Øgaard, 2017). One caveat of nudging via social comparison is that if people get presented with the information that other people are doing less than oneself (e.g., that other people are conserving less water in the household), the effect of the nudge turns around (i.e., people tend to relax in their efforts) (Doran, Hanss & Øgaard, 2017). Still, social comparison is one nudge that can be implemented with relative ease and with promising outcomes. The relevant group that the social comparison is made to is of interest and seems to be an essential element of the effect of the nudge.

In SimpliCITY, a user assigns himself to a specific district that he lives in (and further, that he or she collects various gamified elements for). The relevant group can be therefore the specific district a user lives in. This identification with the relevant group is also fostered by district tours that are offered in the app (e.g., the user can explore all the district has to offer), and there certain challenges that promote competition between districts (e.g., a challenge about which district can ride more kilometres on the bike). Therefore, district identity (i.e., neighbourhood) seems to be a relevant group within the SimpliCITY community. In order to foster sustainable behaviour, a nudge based on social comparison should indicate that other participants are already showing more of the relevant behaviour (e.g., most of the other SimpliCITY users do X already).

4.2 Ethical evaluation of nudging in SimpliCITY

In the literature, nudging is debated as potentially unethical because methods can be used which are not transparent and exploit psychological processes with the effect that people take decisions in a non-reflected, quasi-automatic way (Hansen & Jespersen, 2013; Hausman & Welch, 2010; Sunstein 2015).

While we see the nudging methods intended in SimpliCITY as not problematic in ethical terms, the research will still assess if any of the methods and specific techniques pose an issue when applied in practice. If this would be the case, an appropriate solution or alternative approach will be suggested.

4.2.1 Distinguishing types of nudges

Nudges use different techniques to steer the decision-making of people in a particular direction or affect behaviours directly. Characteristics of these techniques provide the basis to distinguish different types of nudges and to evaluate if these are appropriate in ethical terms.

In the discussion of nudges, researchers and practitioners often refer to two distinctions which characterize the techniques that are being employed:

- if the techniques address "System 1" (automatic) or "System 2" (reflective) cognitive processes, and

- if the techniques work in a "Transparent" or "Non-transparent" way.

We briefly explain the distinctions "System 1" / "System 2" and ``Transparent" / "Non-transparent", and then use a matrix of these distinctions to discuss the different types of nudges. Thereafter, we explain where the method of social comparison is positioned which will be trialled in SimpliCITY.

System 1 vs. System 2

The two systems theory of cognitive processes has been developed by Kahneman (2003, 2011). According to this theory the human brain works in two different ways:

- System 1: processes information fast, uncontrolled and effortless in a quasi-automatic way,

- System 2: processes information slow, controlled and effortful in a reflective way.

It is assumed that people make most judgements and choices of daily life quasi-automatically, i.e. without really making a reflected conscious decision. Automatic here means based on cognitive biases, heuristics and mental shortcuts, while reflective involves following rules of logical thinking, weighing the costs and benefits of various options, or other ways to reach a well-considered decision.

Transparent vs. Non-transparent

The distinction refers to the intention as well as the means employed in a nudge:

- Transparent: the intention is clear and people are made aware or can easily identify the means employed to influence their decision-making or behaviour,

- Non-transparent: the intention is not disclosed and the means by which a certain decision or behaviour change is pursued remain hidden.

Obviously nudges with non-transparent conditions combined with triggering System 1 (automatic) cognitive processes are highly manipulative, while addressing System 2 (reflective) transparently regarding the intention and means appears as a legitimate way of trying to persuade citizens to take a particular decision or change a behaviour.

Table 3 Matrix of types of nudges

	System 1 (automatic) *Nudge affects behaviour directly*	System 2 (reflective) *Nudge affects choice directly*
Transparent	*Transparent influence of behaviour* *Techniques:* Typically, in the form of a technical manipulation *Examples:* Car alarms for seat belts Provide larger household recycling than waste bins Change printer defaults from one-side to double-sided printing	*Transparent facilitation of choice* *Techniques:* Provide information, education and guidance *Examples:* Nutritional labelling of food products Information that most people pay their taxes in time (social norm) Comparison of own energy consumption to those of other people (social comparison)

Non-transparent	Non-transparent manipulation of behaviour	Manipulation of choice
	Techniques: Change the environment (physical arrangements and/or objects) in which people make choices *Examples:* Narrow the side-lines on a road in order to get drivers to slow down Eliminate cues for smoking by keeping cigarettes and ashtrays out of sight Provide smaller plates in self-service restaurants to reduce food waste	*Techniques:* Various techniques, e.g. salience, framing, priming, default opt-in *Examples:* Making one option more salient than the alternative (salience) Framing one decision as involving a potential loss (activating people's loss aversion) Default opt-in, where one must actively opt-out to prevent enrolment in a programme

Source: Hansen & Jespersen, 2013, adapted and extended.

Alongside the enthusiastic communication of successful nudges by governmental agencies and consultancies, there are many critical voices which caution that non-transparent nudging by governments might erode freedom of choice and values of a democratic society.

Proponents of policy-making by nudging argue that due to their "bounded rationality" (Simon, 1957; Kahneman, 2003) people make wrong decisions in vital matters and therefore must be nudged towards decisions and behaviours that are in their best. However, critiques emphasise that also paternalistic policy-makers are subject to bounded rationality and act based on particular political interests and pressures (Mitchell, 2002; Rizzo & Whitman, 2009; Lodge & Wegrich, 2016; Viscusi & Gayer, 2015).

Despite claims to the contrary, nudging may not preserve freedom of choice as the "choice architectures" of nudges are generally designed to determine people's decision-making in a predictable way (Grüne-Yanoff, 2012; Rebonato, 2013; Yeung 2016). This could create a slippery slope of public policy-making on which choices are limited by increasingly restrictive "choice architectures" (Rizzo & Whitman, 2009; Rebonato, 2013). However, much of the debate on policy-making by nudging comes down to the distinction between transparent versus non-transparent nudges and the question if techniques employed in non-transparent nudges are acceptable in ethical and democratic terms. Proponents of nudging argue that non-transparent interventions are acceptable if it can be shown that these support the well-being of citizens and society (Thaler & Sunstein 2009; Sunstein, 2015). Their opponents maintain that public policy should avoid nudges that are questionable in ethical and democratic terms by using only transparent methods or regulatory measures to steer people to behave in a manner that ensures their own and society's good.

Hansen and Jespersen (2013) suggest that in most situations non-transparent nudges should be considered as not acceptable. The reason is that citizens cannot act rationally if it is difficult or impossible to understand the intention and/or the means by which decisions are steered in a particular direction or a behavioural change is pursued. Furthermore, non-transparent nudging would not only manipulate choices in a manner that users cannot see, but also ascribe the responsibility for those decisions to the nudged individuals, decisions they might not have taken otherwise.

Ivanković and Engelen (2019) discuss in greater detail the importance of transparency of nudges in order to guide people in the right way to intended right choices and behaviours. Also other authors emphasise that attempts to change lifestyle choices and behaviours of citizens should have a transparent and coherent basis on which people understand the reasons for their decisions and how they enact them (e.g. Bovens, 2009; Hausman & Welch, 2010; Lin et al., 2017).

4.2.2   Nudging methods in SimpliCITY

The nudging methods that will be trialled in SimpliCITY to increase the use of city services belong to the "System 2" (reflective) and transparent methods. These methods encourage people to take a well-informed decision and change behaviours, for example, through an educational campaign, labelling (e.g. nutritional information labels), or information about what others do or don't (social norms and comparison).

"System 2" and transparent methods can facilitate deliberate, reflective and reasoned decision-making by citizens. Therefore, these methods are the least debated forms of nudging and generally seen as ethically appropriate ways of trying to persuade citizens to take a particular decision and change behaviours (Hansen & Jespersen, 2013; Hausman & Welch, 2010; Ivanković & Engelen, 2019; Lin et al., 2017). Also surveys on citizen's opinion about different nudges show that the public supports these methods with much higher approval rates than other proposed forms of nudging (Reisch & Sunstein, 2016; Sunstein et al., 2018a, 2018b). Using social comparison as nudging within SimpliCITY promotes "System 2", as it is transparent in regards to the aims   (e.g. increase cycling of citizens instead of using the car) and people are not forced to change or limited in their choices.

Regarding the display of participants' results, ethical and legal requirements need to be taken account of. While display of aggregated and anonymized individual results does not pose an issue, display of results of identified participants does, if it is not based on informed consent.

4.3 Experimental design for a digital social comparison nudge

For evaluating the effectiveness of social comparison nudge in this research project, it is planned to send a sample of the users a notification within the app that most of their neighbours are already showing more of a certain intended behaviour (e.g., that they biked more kilometres within a week: "85 % of your neighbours in your district bike more than you last week!"). This notification could also be personalized based on previous information the user provided or on behaviour he or she showed. The sample of users would be randomized (and analyses would be controlled for gender and age). It is expected that users that receive a notification should show more of the intended behaviour than users who do not receive a notification. In addition, it is expected that for users who have previously been more active for their district (i.e., who have a stronger identification with the reference group), the nudge should show an even stronger effect. The nudge can be sent multiple times, a simplified model of the experiment with simulated results can be found in Figure 1. Here, after a few weeks of using the app (and therefore, becoming more identified with a district), users in the control group receive a notification in week 3.
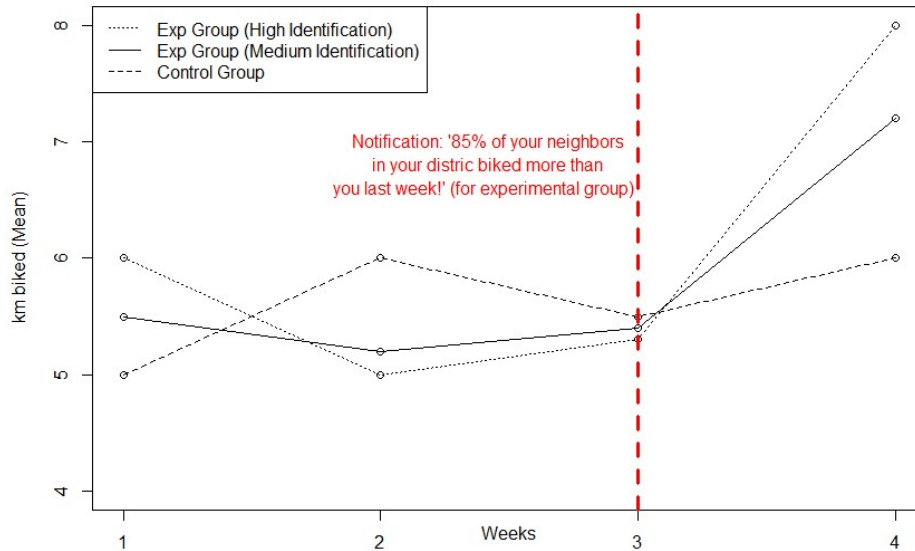
Figure 1 Experimental design and simulated results for social comparison nudge.

Users in the experimental group would receive a notification in week 3 ("85% of your neighbours bike more than you last week"), users in the control group would receive no notification. It is expected that users in the experimental group would bike more following the nudge, and depending on how much the users identified themselves with their district, the effect would be moderated by identification.

5   Limitations and conclusion

In this paper, we presented the research project SimpliCITY, in which two small-scale smart cities aim to scale up regional sustainability services and increase their visibility by means of a novel aggregated service platform and related web-application. The web-application seeks to foster sustainable behaviour in the areas of bike mobility, local production and consumption and social inclusion with elements of gamification and nudging methods. Social comparison is one of the nudging methods that can be applied in this research project. Previous behaviour of the user as well as identification with a district serves to personalize the nudge and moderate the effect.

Although social comparison as a nudging method seems to be a valid tool (Abrahamse & Steg, 2013), theory of planned behaviour (Ajzen, 1991) also teaches us that it is not always straightforward to change a behaviour, even though a person has the best intentions. Therefore, it can be hard to put an effect into practice, and even though people might show the desired behaviour change, it can be hard to validly measure it (e.g., they forget to track their activity on their phone, it rains all week after the notification). Further, long-term effects are still being investigated. It is not clear if

nudges lead to a long-term behaviour change (Marteau et al., 2011) and whether a possible long-term effect holds true for all the different nudging methods. While a long-term effect was demonstrated for a default option as nudging method (Venema et al., 2018), this might not translate to social comparison as nudging method. As the default option is always present and therefore might form a strong habit, a single notification could lead to only a short spike in behaviour change. This aspect will be investigated in the ongoing project and the possibility and effect of sending multiple notifications over time will be explored. Further, ethical and legal aspects (i.e., data handling) of using this nudging method must and will be evaluated throughout the project.

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