Mobility as a service (MaaS): the importance of transportation psychology

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The Importance of Transportation Psychology

1 Introduction

Mobility-as-a-Service (MaaS) platforms provide access to different forms of transport – car- and bike-sharing, cabs and car rentals, trains and buses – offering consumers a comprehensive range of services from travel planning to payment. These platforms act as a centralized marketplace for various modes of transport as well as cross-provider routes, affording individual-level optimization, aligning offerings with the consumer's transportation preferences. Beyond the substantial environmental and societal benefits from making transportation more efficient, MaaS could also improve the commuting experience, which in its current form is deemed the least enjoyable of our daily activities (Kahneman et al. 2004; Chatterjee et al. 2020).

Firms such as Mitsubishi, BP, and Toyota have made significant investments in MaaS in the expectation that it will be widely adopted (Whim 2019). By some estimates, the market could be worth hundreds of billions of dollars in the decade to come (Wagner 2019). However, such dramatic growth cannot be taken for granted in a context where people's transportation habits are deeply ingrained. Given the robust nature of what the decision-making literature calls the *status quo bias* (Kahneman et al. 1991; Samuelson and Zeckhauser 1988) – an inherent preference for the way things are – for MaaS to scale up, consumers will have to abandon the status quo *en masse* in favor of these innovative platform solutions (Mulley 2017).

In addition to posing exciting opportunities for consumers, MaaS also opens up new perspectives to reseachers seeking to understand this significant industrial shift. Examining

MaaS from a psychological perspective, our paper aims to identify design features that undermine its appeal and adoption, and propose novel solutions that are rooted in consumer psychology. In so doing, we aim to encourage further research on the major psychological dimensions of MaaS, as seen through the lenses of perceived control, consumer identity, social factors, and perceived costs to enable MaaS to reach its potential. The following sections expand on a number of psychological concepts along the dimensions mentioned above and how these concepts interact with MaaS judgments and decisions. Throughout the article we highlight future research directions in an attempt to prompt other academics to join the discussion about how best to encourage the adoption of MaaS. More broadly, we argue that transportation research could benefit from more psychologically-informed approaches and call on psychology and transportation researchers to help bridge this gap.

2 Perceived Control

A key difference between MaaS platforms and traditional transportation options is the traveler's perceived control over the outcome – a significant determinant of consumer behavior (Wathieu et al. 2002). A major benefit of MaaS is its ability to provide an automated optimal travel experience. However, consumers may equate automation with relinquishing control, which, in turn, can undermine their sense of psychological power, responsibility, and trust in the platform—all factors that will determine how users respond to MaaS.

2.1 Psychological Power

A key feature of transportation systems is the sense of power derived from controlling a vehicle. Driving at top speed down a highway, for example, imbues drivers with a substantial

sense of power (Gossling 2017). Psychological power, defined as "the capacity to control resources and outcomes, both one's own and those of others" (Rucker and Galinsky 2008, p. 258), reflects an individual's perceived (rather than actual) control (Galinsky et al. 2003) and can extend beyond utilitarian considerations (Chen et al. 2017). Hence, asking commuters to surrender decision-making power to a MaaS platform may put MaaS at a psychological disadvantage.

Likewise, design faults in MaaS platforms could further undermine their perceived control. MaaS routing algorithms inevitably make decisions that will conflict with passengers' preferences, engendering a sense of frustration and a perceived loss of control (Mick and Fournier 1998). This may trigger what is referred to as *algorithm aversion*—a dislike of and lack of confidence in algorithm-made recommendations, especially after a mistake (Dietvorst et al. 2015).

Conversely, MaaS platforms may boost the consumer's perceived control by offering a variety of transportation modes to choose from, as well as relief from erratic traffic conditions by improving the reliability of the system. However, such perceived control may not be salient to commuters, as they tend to be unaware of the traffic they are avoiding when riding the subway, for instance. On the upside, MaaS applications could boost the consumer's sense of control (Wortman 1975) by providing timely updates and informative notifications, e.g., the real-time location of the next bus (Watkins et al. 2013), how much travel time s/he has saved, etc.

Providing categorical options to consumers could further enhance their sense of control (Mogilner et al. 2008). Such options complement the core appeal of MaaS, to simplify an otherwise complex decision. For example, MaaS platforms could give passengers more decisional power (Langer and Rodin 1976) by asking passengers whether they want to optimize the duration of a trip or its timing.

2.2 Responsibility

MaaS entails individuals' abandoning the sense of control that they derive from their psychologically comfortable daily commute. A traveler who usually takes the train might be directed to take a bus-and-e-scooter combination one day, and a rideshare the next. So, while the shift from single-solution transportation to a multi-mode arrangement is a key benefit of MaaS because it solves first- and last-mile problems (the inability of one mode of transport to carry passengers over the entire journey), the added complexity involved may discourage its adoption.

The reluctance to abandon the status quo derives from deeply ingrained habits that are automatic in nature and resilient to intervention (Ji and Wood 2007). These habits will hinder the switch to MaaS, particularly if people were asked to accept responsibility for attending to each day's route offering. For instance, offering many alternative routing options could frustrate users due to choice overload (Iyengar & Lepper 2000), resulting in negative word of mouth, which could turn off potential adopters. What's more, complex routes may require knowing where to go, how to pay, and other nuances for transit options. Research shows that individuals prefer to avoid such responsibilities (Mathes and Kahn 1975) and avoid making frequent minor decisions (Gigerenzer and Gaissmaier 2011).

Yet, although route complexity seems to add responsibility in a MaaS setting, it actually reduces it, albeit in less salient ways. Indeed, finding ways to make the lowered-responsibility aspects of MaaS more salient presents another research opportunity. For example, MaaS apps could highlight that MaaS platforms centralize payment and eliminate the need to monitor the balance on multiple travel passes or have the exact change available, or that the platforms offer contingency planning for missed buses and trains.

Despite being responsibility-averse, people's ownership of a product tends to increase their perception of its value (Kahneman et al. 1991). This presents another potential avenue for research: exploring and testing ways to boost a sense of ownership of MaaS platforms. This could draw on previous work that shows that a sense of ownership derives from people's perceived control over a product (Liu et al. 2012), comprehensive knowledge of a product (Pierce et al. 2003), or even thinking about a product (Carmon et al. 2003).

2.3 Trust

For users to embrace MaaS, they need to be able to trust that the travel experience will be enhanced by the app – it will improve on the outcome they themselves could have achieved (without a tech-based intermediary). MaaS platforms involve multiple transit providers, some of which may not be familiar to the user. Compared with their customary vetted mode of transport (e.g., taking the same metro line on a daily basis), they must be able to trust the quality consistency of all providers and be willing to put their financial trust in a MaaS platform.

Initially, consumers may be reluctant to pay for an annual subscription for fear that they would lose it. Over time, however, trust will deepen as a result of brand equity (Tax et al. 1998): the brand name of a MaaS platform will signal its quality and reliability.

However, before a platform can establish experience-based trust, it will have to signal the competence of the network – show alignment with its users' interests as a signal of trustworthiness (Sirdeshmukh et al. 2002). At the same time, the platform may have to compensate on dimensions such as affordability and customer service if any of the network partners are lacking in either dimension. Ultimately, consumers' attitudes toward the network can only be as positive as its weakest component (Dick et al. 1990). Hence, another

promising direction for future research would be to examine potential sources of consumer uncertainty about MaaS adoption, and ways to mitigate them to engender consumer trust.

3 Consumer Identity

Consumers signal their identities – to themselves and to others – through their consumption choices (Spence 1973). Such signals are particularly effective when they are both salient and appear costly. Buying a high-end solar-powered electric bike or a fuel-efficient vehicle (e.g., Toyota Prius) meets both criteria.

3.1 Self-signaling

Self-signaling – demonstrating desirable attributes to ourselves (Dhar and Wertenbroch 2012) – can be achieved through our choice of transportation mode (Barbarossa et al. 2015). While vehicle ownership is often associated with a sense of accomplishment and high status (Moody et al. 2019; Zhao and Zhao 2018), the adoption of MaaS could signal positive attributes such as concern about the environment (Schwartz 2012). However, the environmental impact of MaaS is not typically salient to consumers and hence makes for a weak signal (White et al. 2019). Seen from a different angle, signaling environmental concerns through MaaS usage may not be perceived as costly to the consumer, due to the many benefits of switching. Future research could thus explore how MaaS could viably provide powerful self-signals.

3.2 Other-signaling

Research on conspicuous consumption – influencing others' perceptions via our consumption choices (Veblen 1899) – has demonstrated how we use purchases to signal to others characteristics such as our wealth, personality, and identity (Berger and Heath 2007; Sundie et al. 2011). For example, driving a Toyota Prius or a Tesla with a distinctive design (rather than an ordinary gasoline vehicle) can signal environmental consciousness (Sexton and Sexton 2014), just as riding to work on a bicycle can signal athleticism.

Since identities are fluid and context-dependent (Chan et al. 2012), MaaS platforms could leverage the variability afforded to users to match their transit choices with their identity needs. However, signaling through MaaS can be difficult because usage is neither attention-grabbing nor is it perceived as costly. Whereas airline passengers signal status through their chosen class of travel (first, business, economy), many MaaS transit options such as e-scooters and buses do not signal status. The challenge, then, is to develop cues that signal desirable features of MaaS adoption to others in an effective and credible manner.

4 Social Factors

4.1 Social Constraints

Being unconstrained provides a sense of freedom, autonomy, and satisfaction (Deci and Ryan 1987) and is highly valued by consumers. Seen through this lens, the public nature of MaaS options appears to be a constraint; travelling in a confined space with unfamiliar others creates pressure to conform to social norms (Asch 1955) – being polite, not initiating conversation with other commuters, etc. Designing interventions to alleviate these perceived social constraints is thus a key challenge associated with MaaS adoption. For instance, increasing passengers' control over the social component of the commute may make MaaS

more attractive for both privacy-seeking passengers and people who require a gentle nudge to take advantage of the potential in public transport for acquiring greater social connectedness.

4.2 Scale Concerns

For any emerging product whose appeal depends on the size of its demand, achieving scale is a major challenge. MaaS relies on network effects – it must reach a critical mass to succeed (Katz and Shapiro 1986; Shriver 2015; Zhou and Li 2018). Moreover, an option's perceived popularity in and of itself can significantly boost its appeal (cf. Cialdini's [1993] notion of *social proof*, Festinger's [1954] *social comparison theory*, and Leibenstein's [1950] concept of the *bandwagon effect*). Conversely, some consumers may be reluctant to adopt something that is not yet popular, preferring to wait until it becomes mainstream (Jacoby 1971). In this sense, MaaS may have to capture the transportation zeitgeist for it to be considered a viable option by mass consumers. Here again, researchers and policy makers can investigate cost-effective interventions to address demand-perception concerns.

5 Perceived Costs

5.1 Salience of Cost

Cost may be a salient factor in consumers' willingness to adopt MaaS. MaaS platforms typically offer two different forms of payment: pay-per-use and subscription-based. Under the subscription model consumers experience a significant but infrequent *pain of paying* (Prelec and Loewenstein 1998), unlike pay-per-use where the pain is less keenly felt. Research should examine the circumstances under which large-but-infrequent versus small-but-frequent payments are more or less appealing.

5.2 Switching Costs

Travelers may find it costly to switch to MaaS, given the psychological cost of disrupting the status quo and consumers' tendency to compare MaaS with their existing mode of transport. In psychology, the existence of *loss aversion* – the tendency of losses to loom larger than equivalent gains (Kahneman and Tversky 1979) – is well established. Accordingly, in the context of switching to MaaS, gains will weigh less heavily than the losses incurred.

On the other hand, commuters value reliability (Small et al. 2005), which MaaS may improve by reducing variability in travel time through real-time cross-modal coordination. The stronger aversion to being late (a type of loss) than the pleasure of being early (a gain) could give MaaS an edge over traditional modes of transport. This points to research opportunities and creative framing interventions (Tversky and Kahneman 1981). For instance, communicating that the status quo entails giving up an the greater reliability and punctuality of MaaS, will be more impactful than presenting the potential upside of MaaS on these dimensions.

5.3 Time Cost

Time cost will be pivotal to MaaS adoption. The disutility of time spent will differ depending on when and how it is assessed, predicted, experienced, and remembered (Morewedge 2015) – all aspects that must be considered by researchers and MaaS platform planners as each type of (dis)utility has different determinants and consequences (cf. Carmon and Kahneman 1995). For example, predicted utility, key to MaaS adoption, can be managed by shifting traveler's focus away from time costs and towards appealing aspects, such as ride comfort

and social opportunities; experienced utility will reduce attrition during a MaaS journey and is improved by minimizing anxiety, such as through avoiding jammed roads even if they are faster; and remembered utility will impact word-of-mouth, which determines widespread adoption, and could be managed through pleasant surprises, such as arriving early by design (inflating the expected duration). Here again, research on the determinants and consequences of various types of utility in different contexts is needed to guide the design of MaaS systems. More generally, MaaS offers an excellent research context for uncovering previously unexplored interactions between different types of utility.

6 General Discussion

In this article, we have explored MaaS from a consumer psychology perspective, suggesting how the core features of MaaS interact with four social and cognitive psychological dimensions – specifically, perceived control, consumer identity, social factors, and perceived costs. For each dimension, we have described how it poses obstacles to adoption as well as ways in which it could be leveraged to boost the appeal of MaaS offerings (see Figure 1 for a summary of key suggestions). Our goal is to share these perspectives with practitioners as well as to spur further research on the topic of MaaS adoption.

<< Insert Figure 1 here >>

MaaS has considerable individual and societal benefits. The innovative concept of centrally managed transportation platforms is a promising substitute for the current inefficient and inflexible model – and a prime reason for the substantial investment that MaaS has received in anticipation of mass adoption. Perhaps the greatest hurdle to adoption is the status

quo – the existing transport system that consumers will have to abandon *en masse* for MaaS to succeed. MaaS designers would thus do well to develop products that make the transition as tempting and smooth as possible, with assistance from consumer researchers.

Besides the key dimensions discussed in this paper, other factors may inhibit the adoption and effectiveness of MaaS. One example is that MaaS can suggest different routes and modes for every trip, requiring the traveler to process all of these options in detail. This may reduce risk-taking (Sagristano et al. 2002) and, in turn, discourage the adoption of MaaS. More generally, MaaS platforms need to optimize more than time-to-arrival and the immediate out-of-pocket cost – they should be designed to reflect consumer concerns about safety, the salience (or lack thereof) of direct and opportunity costs, and environmental impact and social considerations.

For such nuanced multi-faceted optimization to be feasible, platform developers will have to make psychologically informed decisions on how to elicit, frame, and account for such factors. Research on how to apply principles of choice architecture such as defaults, simplicity, and pre-commitment levers (Thaler and Sunstein 2009) could greatly benefit providers as they calibrate their platforms. Clearly, calibration will depend on specific insights from potential MaaS users. To tailor offerings accurately, it is essential to observe users' revealed preferences, collect expressed preference data (Danaf et al. 2019; Xie et al. 2019), and run controlled testing for a limited time on subsets of the population. In this way, the measures implemented will enable better informed decisions from MaaS platforms and policymakers alike.

The effective and widespread adoption of MaaS platforms and other new transportation technologies requires recognizing and addressing psychological roadblocks, as well as transforming barriers into opportunities. What's more, while current transportation systems focus on safety and efficiency, MaaS illustrates that emerging technologies can

improve other important dimensions. More broadly, we believe that transportation psychology research can both generate rich new theoretical insights and help develop transportation systems that significantly improve consumer well-being. We call on researchers to help this important cause.

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