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RESEARCH PAPER

Sharing Yet Caring

Mitigating Moral Hazard in Access-Based Consumption through IS-Enabled Value Co-Capturing with Consumers

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Abstract The quest for creating smart and sustainable cities entails various substantial challenges, such as environmental degradation and a shortage of space. To negotiate these hurdles, innovative approaches must be implemented. A key aspect in this regard is the shared use of resources via forms of access-based consumption. Owing to advances in the digitalization of contemporary societies, these concepts have recently attracted both consumer and scholarly interest. However, the digitally enabled separation of ownership and use brings along the risk of moral hazard by consumers using resources in careless or wasteful ways, which is detrimental to the sustainability of the overall system. In this study, the authors conceptualize and empirically investigate how these adverse effects can be mitigated by applying the potentials of connectivity and digital data to enable users to participate economically while acting favorably from a collective perspective. The results of the quasi-experimental research design, situated in a carsharing context and comprising data records of 2,983 bookings, indicate that this form of value co-capturing with consumers can significantly motivate users to alter their behavior. From these findings, the authors derive important implications for research on the sustainability of digital business eco-systems in the specific context of smart cities.

Keywords Access-based consumption · Carsharing · Smart cities · Agency theory · Value co-capture

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1 Introduction

Contemporary cities can be viewed as intersections of two important societal megatrends: urbanization and digitalization (Tilson et al. 2010). Cities are growing in scope and population worldwide, while environmental pressure rises inexorably (Corbett and Mellouli 2017). At the same time, "[t]he emergence of digital technology gives us a chance to fundamentally reshape the landscape of cities" (Yoo et al. 2010, p. 638), creating opportunities to alter various socio-technical arrangements (Tilson et al. 2010). For instance, information systems (IS) have been widely credited for their facilitation of service business models that allow consumers to gain temporary access to goods – a phenomenon that has become particularly popular in space-constrained urban areas (Bardhi and Eckhardt 2012). Business models for access-based consumption (ABC), such as short-term lodging (e.g., Airbnb), designer dresses and accessory rentals (e.g., Rent the Runway), and sharing tools (e.g., NeighborGoods), bikes (e.g., Ofo), or cars (e.g., car2go), can provide substantial environmental and societal benefits due to their better utilization of resources (Leismann et al. 2013). However, the heterogeneity of actors involved can cause problems for such business models. As described by Cohen and Kietzmann (2014), the diversification of providers gives rise to several conflicts of interest that might hinder the positive sustainability effects of their individual and collective initiatives, making it necessary to redefine the relationships between private solution providers and local authorities. In addition, Bardhi and Eckhardt (2012) allude to a dark side of such business models at the consumer interface that results from the separation of use from ownership. One of their participants, carsharing user Chuck, enthused, "You can just beat the hell out of it; it's not your car. Like, I don't have to think about changing the oil; I don't have to care whether or not the tires are flat. I don't care about any of it; it's not my car. And you know some magic car fairy will come and fix whatever is not right with it later. So if I destroy the suspension, so be it! Somebody will fix it. Not me" (Bardhi and Eckhardt 2012, p. 891). Similar problems occur in several other well-known instances of ABC, such as increased resource and energy consumption in commercial accommodations (Miao and Wei 2013) or "excessive wear and tear and overuse of the product" (Leismann et al. 2013, p. 192) in shared tool usage, indicating the systemic nature of such potential downsides associated with ABC. Although prior research has shown that digital technologies can enable the societally and environmentally valuable diffusion of ABC (Belk 2014), it has neglected their capacity to address the potential adverse behavioral consequences of the associated business models (Majchrzak et al. 2016).

The decoupling of ownership and use leads to principal–agent relationships (Eisenhardt 1989), i.e., "transactional arrangements between self-interested parties with incongruent goals in the presence of uncertainty" (Pavlou et al. 2007, p. 106). The potentially emergent moral hazard of consumers using shared goods in a careless or wasteful way not only leads to excessive resource consumption but may also result in accelerated deterioration or even serious damage to the goods accessed. These threats can endanger the enduringly profitable and environmentally friendly large-scale provision of such business models. However, "there is a dearth of research of how sharing economy business models work, what their sustainability impacts are, and how they are able to align incentives with key stakeholders to ensure longevity of their operations" (Cohen and Kietzmann 2014, p. 294). Prior IS research has dealt with diverse mechanisms for solving agency conflicts (Schieg 2008). For instance, digital technologies have been described as an important means of developing mechanisms for increased monitoring and sanctioning (e.g., Dyal-Chand 2015). However, what these measures have in common is a focus on constraining human agency by means of penalties and even exclusion. While appropriate in some contexts, in the case of transformation towards smart and sustainable cities – where consumers can draw from a wide range of other options, including less sustainable ones, such as using personal cars – such measures might endanger the adoption of ABC in the first place. The perspective of creating target congruity (Schieg 2008) between the key stakeholders of ABC is therefore an important yet poorly understood perspective (Cohen and Kietzmann 2014).

A central trait of digitally enabled business models such as ABC is the changing role of the consumer within digital business eco-systems (El Sawy and Pereira 2013): whereas before they acted as pure consumers, they are now moving towards becoming co-creators of value (Lusch and Nambisan 2015). Still, as with any business, the sustainable viability of these business models relies on not only creating but also capturing value (Priem et al. 2013). Prior research on value co-capture (El Sawy and Pereira 2013) has indicated its economic potentials in corporate contexts (e.g., Bharadwaj et al. 2013). However, professional usage differs significantly from decision making in peoples' private lives (Hess et al. 2014), and the role of the consumer has not yet been elevated towards enhanced responsibility and agency. Extending the concept of value co-capture to include consumers is essential due to the direct impact of consumer behavior on the sustainability – i.e., economic, environmental, and societal performance – of ABC. For the case of carsharing, Firnkorn and Müller (2011) explicitly suggest "implement(ing) mechanisms to reward efficient driving" (p. 1527). Therefore, we consider digital technologies not only as enablers of such business models but also as a means of overcoming their adverse side effects. More specifically, we contend that letting consumers participate economically in decreasing operating costs in ABC can mitigate moral hazard and generate additional value for all parties involved. The example of carsharing is particularly suitable for studying this relationship due to its importance for the sustainable development of space-constrained cities and the direct influence of consumer behavior on the sustainability of these business models. Therefore our study examines the following research question:

How does IS-enabled value co-capturing with consumers influence ABC in the case of carsharing? To address this question, we collaborated with a medium-sized carsharing provider in Germany and modified the existing business model by implementing an IS-enabled value co-capturing mechanism. By measuring customers' individual driving styles in terms of acceleration and deceleration behavior and rewarding them for favorable actions, we aimed to mitigate moral hazard, i.e., reckless and wasteful driving. To investigate the concept of value co-capturing with consumers under realistic conditions, our quasi-experimental time-series design (Campell and Stanley 1963) examines a series of observations over a period of

13 months, comprising 483 consumers and 2983 rides. We determine the financial consequences of our approach and position it in a holistic multi-agent smart city framework, which illustrates the need to account for the interrelationships among consumers, ABC providers, and local authorities when implementing and evaluating such IS-enabled measures. With our study, we contribute to the emerging literature on the economics of digital business eco-systems and provide a perspective relevant to increasing the sustainability of such service business models with widespread and transformational impacts on the landscapes of cities (Almirall et al. 2016).

2 Theoretical Framework

2.1 The Role of IS in the Emergence of Access-Based Consumption

ABC describes transactions in which consumers pay for temporary access to desired goods (such as accommodations, cars, bikes, tools) but no transfer of ownership takes place (Bardhi and Eckhardt 2012). While business models that emphasize the provision of temporary access to goods as an alternative to ownership are nothing new, advances in IS have made them possible at scale (Cohen and Kietzmann 2014). Carsharing, for instance, has existed for more than half a century (Hildebrandt et al. 2015). However, most of the first-generation business practices were relatively short lived and profitable organizations with large customer bases have only recently emerged (Shaheen et al. 1998). Similar observations can be made for other instances of ABC, such as sharing tools, fashion, or accommodations. Here, the increased penetration of digital technologies (Bharadwaj et al. 2013), together with the emergence of digital platforms and infrastructures (Tilson et al. 2010), has recently begun to transform the relevant set of business models by enabling "novel and convenient processes through which products are transferred and exchanged" (Kathan et al. 2016, p. 665). At the same time, pervasive digital technologies bring along new collaboration opportunities for firms. Digital business eco-systems emerge (Bharadwaj et al. 2013), changing the roles and rules of relationships among organizational partners while also empowering consumers and acclimating them to participating in joint collaboration (Lucas et al. 2013) as co-creators of value (Lusch and Nambisan 2015).

In contemporary carsharing operations, providers make use of the options granted by pervasive connectivity and equip their fleets with digital technologies that enable automated processes and data-driven management of their services. Through smartphone applications, consumers are able to locate, book, access, and use a desired vehicle while an invisible IS collects data to automatically bill the service usage (Wagner et al. 2014). Hence, by rendering the associated business models more efficient, reliable, and convenient (Lovelock and Gummesson 2004), IS enables the decoupling of ownership and use in various scenarios, which was previously impossible due to high transaction costs.

2.2 Access-Based Consumption for Increased Sustainability in Urban Areas

During the past decade, ABC has become particularly attractive in urban areas suffering from high population density and space limitations, e.g., in terms of parking or housing (Willing et al. 2017). These service business models present valuable benefits for consumers, who acquire consumption time with physical goods "they could not afford to own or that they choose not to own" (Bardhi and Eckhardt 2012, p. 881). Unwillingness to own may stem from space constraints; the attempt to avoid additional costs connected to ownership, such as maintenance and repair (Lovelock and Gummesson 2004); or the simple desire to maintain adaptability and flexibility in personal life (Kathan et al. 2016).

ABC business models entail transformational impacts for various industries, such as automotive, real estate, and manufacturing (Almirall et al. 2016), as they cover key pillars of human life, e.g., work (co-working spaces), mobility (bike- or carsharing), overnight stays (accommodation sharing), and leisure activities (shared tools for household or gardening tasks) (Martin 2016). With the potential to fundamentally restructure contemporary economies towards sustainable business practices (Cohen and Kietzmann 2014), ABC represents an important building block in the transformation of our cities towards increased economic, environmental, and societal sustainability (Corbett and Mellouli 2017). The benefits of these business models mainly stem from improvements in resource efficiency and the alteration of consumption patterns (Belk 2014; Willing et al. 2016). More specifically, sharing accommodations, tools, or cars can lead to better utilization of otherwise idle resources (Almirall et al. 2016). Each carsharing car, for instance, could replace 9–13 privately owned vehicles (Martin et al. 2010) while at the same time decreasing the total number of kilometers driven and reallocating travel demands to other, more sustainable means of transportation, such as buses, trams, or subways (Shaheen et al. 1998). Carsharing has therefore been reported to mitigate a variety of mobility problems, such as congestion, emissions, and shortages in parking space (Willing et al. 2016). Even greater benefits can be achieved when combining ABC with sustainable technologies (Firnkorn and Müller 2011), as illustrated by the popular example of car2go, a carsharing provider that operates electric vehicles in their fleet. However, prior research has also emphasized that ABC is not sustainable per se but rather is heavily dependent on consumer behavior (Leisman et al. 2013; Kathan et al. 2016).

2.3 Agency Conflicts in Access-Based Consumption

Although sharing business models are becoming increasingly relevant for the development of smart and sustainable cities, the heterogeneity of actors involved unleashes several conflicts that may compromise their positive outcomes (Cohen and Kietzmann 2014). Agency theory (Eisenhardt 1989) provides a valuable theoretical lens for better understanding the underlying problems. The perspective refers to transactional arrangements between self-interested actors that are shaped by information asymmetries and incongruent objectives (Pavlou et al. 2007). In the smart city context, Cohen and Kietzmann (2014) applied the theory to investigate conflicting goals in the relationship between local governments and shared mobility solution providers and called for more research to "explore the various, and often contradictory roles the different agents and principals play in sharing economies" (p. 293).

In this study, we apply agency theory to understand the relationship between providers of ABC (i.e., principals) and consumers (i.e., agents). We contend that by separating ownership from use, ABC business models are susceptible to several obstacles to the enduringly profitable large-scale provision of these services and the associated environmental and societal gains. Belk and Costa (1998) theorize on the correlation between ownership and self-expression: as consumers usually identify with their personal property, the preservation of their goods becomes natural to them. This attitude often changes when consumers do not own the goods they use (Bardhi and Eckhardt 2012). In carsharing, consumers pay a service fee to access a vehicle, while the service provider owns the physical asset and is responsible for all associated activities (e.g., maintenance), risks (e.g., insurance), and costs (e.g., fuel). Table 1 explains the resulting agency conflicts in greater detail by applying the six characteristics by Pavlou et al. (2007) to a typical carsharing setting.

The absence of the principal at the time of use by the agent (see row 1 of Table 1) in carsharing and other instances of ABC leads to information asymmetries (see rows 4 and 6). At the same time, the goals of principals and agents do not align (see row 2): providers generally aim for profits whereas consumers seek to minimize costs and maximize joy. Hence, consumers might engage in reckless and wasteful driving (see row 3) when not bearing the consequences for such behavior (see row 5). Due to these circumstances, typical carsharing business models are particularly susceptible to moral hazard, as illustrated earlier with the example of carsharing user Chuck (Bardhi and Eckhardt 2012). However, the aforementioned problems – particularly concerning information asymmetries (row 4) but also regarding the divergence of interests (row 2) – indicate the potential of IS to mitigate potential negative consequences.

3 Towards IS-Enabled Value Co-Capturing with Consumers to Mitigate Moral Hazard in Access-Based Consumption

To be sustainably successful, ABC business models must consider conflicts resulting from principal–agent constellations. While monitoring and enforcement (see Table 1) become feasible in more contexts due to advances in digital technologies and infrastructures (Dyal-Chand 2015), their applicability in situations where consumers have a variety

Table 1 Agency perspective on carsharing

Principal-agent characteristics	Owner-consumer relationship in carsharing
Human action: principal delegates decision power to an agent who acts on his behalf	Provider (principal) delegates the temporary usage right to the consumer (agent) operating the vehicle
Divergence of interests: goals of principals and agents do not align	Providers aim for profits. Consumers want to satisfy their personal mobility needs, i.e., getting from one place to another as conveniently, enjoyably, cheaply, and fast as possible
Potential for agent's gainful exchange: possibility for agents to gain by shirking or acting opportunistically	Consumers might engage in reckless and wasteful driving
Difficulty in monitoring and enforcing human action: principals cannot easily monitor agents or enforce their expected actions	Providers cannot easily monitor their customers and force them to treat the vehicle in a desired way
Agents not bearing the consequences of their actions: agents act on behalf of principals who own the assets managed	The provider pays for any increased costs for energy or vehicle maintenance resulting from reckless driving
Temporal duration: there is a time lag in which the agent's actions can be manifested	Increase in operating costs resulting from reckless driving is sometimes only apparent in retrospect, e.g., during maintenance

of other options with less surveillance and fewer penalties (such as own car usage) must be questioned. A carsharing provider operating with tight digital monitoring and associated sentencing mechanisms might encounter resistance from consumers or a decline in customer growth. The behavioral impact of such measures is also unclear, given that "behavioral psychology generally ascribes stronger effects to rewards than punishments" (Schall and Mohnen 2015, p. 2628). Furthermore, although digitally enabled monitoring might help track usage behavior, thresholds regarding the sanctioning of behavior might be hard to define. Differentiating between individually induced driving patterns and the role of external influences is not trivial; the limited predictability of events beyond their control might deter consumers even more. Thus, psychological as well as practical factors constrain the possibility of mitigating moral hazard via only monitoring and enforcement.

In addition, various attempts have been made to assess the potential of IS with regard to a harmonization of interests (Schieg 2008). For instance, Bui and Veit (2015) investigate the effects of gamification using a tree visualization that changes its appearance based on driving style to foster sustainable driving in carsharing services. Similarly, Tulusan et al. (2012) demonstrate that eco-feedback apps can reduce fuel consumption and CO_2 emissions in the case of corporate car drivers. In general, the positive effects of feedback systems have been highlighted in various contexts. For instance, Loock et al. (2013) draw on the case of electricity consumption in private households to reveal that web-based feedback systems stimulate energy-efficient consumption behavior. Tiefenbeck et al. (2016) confirm these findings with regard to showering. While these approaches are based on intrinsic motivation, harmonization of interests can also be achieved by applying various forms of extrinsic motivation, such as incentive schemes (e.g., Sappington 1991). However, this perspective remains underresearched for the case of ABC, where the economic, environmental, and societal benefits depend largely on consumer behavior (Leisman et al. 2013; Kathan et al. 2016). For the case of large-scale carsharing operations, Firnkorn and Müller (2011) conclude that it might be beneficial to implement mechanisms incentivizing efficient driving: "Already today, insurances offer pricing schemes depending on the style of driving, and why should the efficient driving of car-sharing vehicles not be rewarded once technologically feasible?" (p. 1527).

Therefore, in this study, we argue that the emerging possibilities of digital technologies allow not only for the provision of new co-created services that provide value-in-use (Lusch and Nambisan 2015) but also for mitigating their negative side effects. In line with this argumentation, prior research has reached a consensus on the notion that creation of value is not enough to explain the sustained success of a firm in modern economies (e.g., Veit et al. 2014). Instead, the perspective of firms capturing value from their business models must also be considered (Priem et al. 2013). While prior studies have delineated the importance of IS in enabling value co-creation – i.e., collaborative activities of creating value-in-use for the customer in a particular context (Lusch and Nambisan 2015), including the mobility domain (Teubner and Flath 2015) – knowledge of its ability to facilitate value co-capture is scarce. Recent research has described emerging methods of IS-enabled value capturing, such as sharing profits with network partners (e.g., Bharadwaj et al. 2013). However, these examples do not account for the role of consumers and their participation in value creation and capture and "it is doubtful that traditional models and theories developed in a working environment can be applied unchanged to the private usage context" (Hess et al. 2014, p. 250). With our study, we aim to address this gap. We contend that creating target congruity (Schieg 2008) between principal and agent via IS-enabled value co-capturing with consumers can mitigate moral hazard in ABC, thus generating additional value for all parties involved.

4 Methodology

4.1 Research Design and Data Collection

We collaborated with a medium-sized carsharing operator in Germany, allowing us to examine our research question under realistic conditions. We modified the existing business model and implemented an IS-enabled value co-capturing mechanism aiming to motivate consumers to reduce reckless and wasteful driving. To operationalize value co-capturing with consumers, we employed a bonus scheme that let consumers participate economically in decreasing operating costs captured from their changed behavior. As we needed usage-related metrics to measure driving behavior, we adjusted the software of the existing data loggers in eight electric vehicles used as test vehicles. In addition to the data necessary for regular carsharing operation, we extended the monitoring functions of the in-vehicle data loggers to collect one data record per second, precisely monitoring driving behavior. The information was transferred to a back-end server in regular intervals via mobile communication networks. For our bonus scheme, we decided to capture drivers' celeration (i.e., acceleration and deceleration) behavior during a trip (af Wåhlberg 2006), as evaluating driving behavior in terms of acceleration and deceleration is quite a common approach in empirical research (e.g., af Wåhlberg 2007; Bui and Veit 2014; Schall et al. 2016).

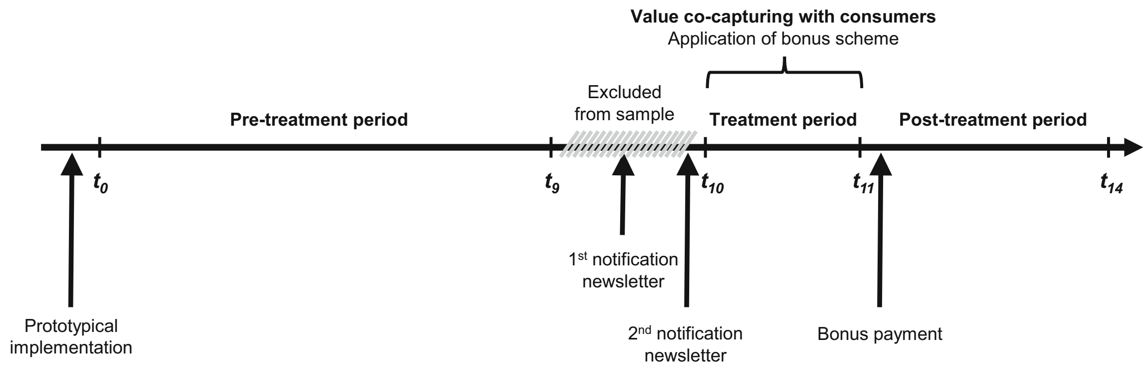

Fig. 1 Research model

To inform the carsharing customers about the bonus scheme valid for the operator's electric vehicles, we sent two newsletters (two weeks before and right before initiating the mechanism) using the provider's mailing list. Thus, there were no restrictions concerning the participation of customers. The newsletter informed them that they would receive a bonus when driving cautiously and farsightedly. However, they did not receive any information on the type and amount of this bonus beforehand. During the treatment month (with the applied bonus scheme), celeration profiles were recorded for each booking and evaluated in light of a reference value calculated from the data records of the pre-treatment period. Subsequently, all participating customers received an invoice including information about their trips during the treatment period. A celeration score was displayed for each trip. If their score was better than the reference value, a positive premium was declared in green, otherwise a negative one in red. At the end, all premiums were summed up for each customer. If the resulting value was positive, a bonus was added to their normal bill. Figure 1 illustrates our research design.

Because the notification about the application of the treatment might have biased driving behavior, we excluded the respective month from our sample. Thus, our quasi-experimental time-series design (Campell and Stanley 1963) comprises a series of observations over a period of 13 months (395 days) comprising 2983 bookings and 39,332,432 vehicle records. This allowed us to study actual decision processes in real-life conditions, yielding a higher external validity than a laboratory experiment with a strong controlled environment (Harrison and List 2004). Moreover, applying a time-series design offers essential advantages with respect to internal validity as the pretest observations allowed us to analyze whether any trends existed in our data prior to treatment (Campell and Stanley 1963). By doing so, we were able to study other effects that may alter driving behavior, such as seasonality and local traffic patterns, which helped us to select reasonable control variables for our regression analysis.

4.2 Variables

4.2.1 Dependent Variable: Celeration

To investigate the implementation of IS-enabled value co-capture as instantiated in the bonus scheme, we measured customers' celeration behavior as stated above. We opted for the celeration profile for several reasons. First, this measure has been reported to be stable over time (af Wåhlberg 2003). Second, although previous studies have measured the impact of different driving styles on fuel consumption (e.g., Schall et al. 2016), the latter is rather an outcome of driver behavior and would be inappropriate in our setting, as several confounding variables, such as seasonality, could strongly influence the energy consumption of the electric vehicles. Moreover, prior research has found that customers' celeration behavior is associated with a variety of effects, such as traffic flow consistency, energy consumption, CO_2 emissions, risk of accidents, and wear and tear of tires, brakes, etc. (e.g., Siero et al. 1989; af Wåhlberg 2007; Schall et al. 2016). Hence, in light of the key challenges of contemporary cities, the celeration profile seems to be an appropriate indicator for the sustainability of carsharing usage.

The in-vehicle data loggers collected one data record per second, precisely monitoring customers' celeration behavior. Assessing values on both sides of zero allowed us to capture both harsh acceleration (affecting, e.g., the vehicle's consumption), as well as strong and abrupt braking maneuvers (leading to increased wear and tear of tires, brakes, etc.). Figure 2 illustrates the acceleration and deceleration behavior of a sample trip. Following af Wåhlberg (2006), we calculated celeration as the mean of all absolute acceleration and deceleration values during a trip.

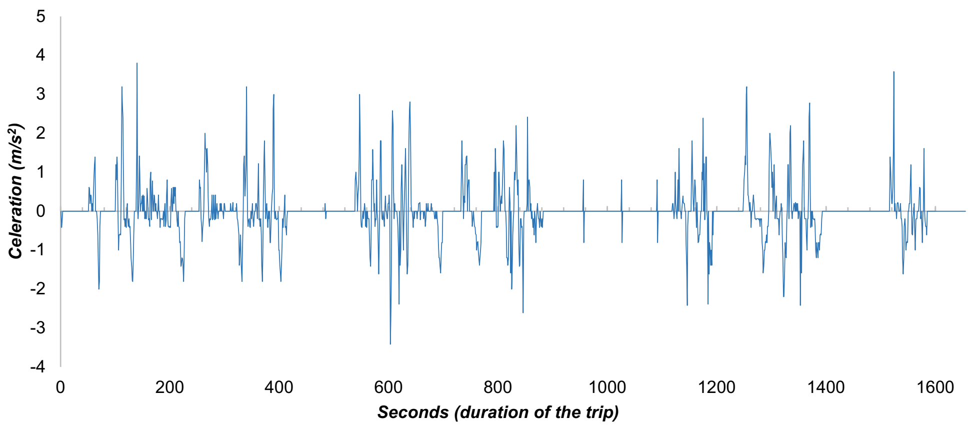

Fig. 2 Example illustration of a celeration profile

4.2.2 Independent Variable: Bonus Scheme

To measure whether reckless and wasteful driving was mitigated by monitoring usage and allowing carsharing customers to participate in decreasing operating costs captured from their adapted behavior, we created a dummy variable indicating whether the booking lies within the timeframe of our treatment period.

4.2.3 Control Variables

We included a broad set of control variables commonly applied in empirical studies on driving behavior that might impact celeration behavior (e.g., af Wåhlberg 2007; Schall et al. 2016). Specifically, we included driver, trip, weather, and traffic controls. Regarding the driver's characteristics, we included a control for the familiarity of carsharing customers with electric vehicles, incorporating *experience* measured as the number of monthly electric vehicle trips prior to the one considered. Moreover, we included a dummy control for *gender* (female). In addition, we extracted trip-specific information from the in-vehicle data loggers. To account for different driving experiences in terms of congestion and operating mode, i.e., city, interurban, or highway, we included controls for *distance* and *average spee*d. Trip distance is calculated as the natural logarithm of kilometers driven. As previous research on electric vehicles has highlighted the significance of range anxiety for their use (e.g., Willing et al. 2016), we integrated a control variable for the battery's state of charge (*SOC*) at the beginning of each tour. Moreover, we used data provided by a local meteorological station to include controls for weather conditions: a dummy variable for *snow* and continuous variables for *temperature*, *rainfall*, and *wind*. We further accounted for systematic changes of traffic conditions, e.g., due to school and commuter traffic or vacations, by incorporating dummy controls for *holiday* periods and *weekend*s. Moreover, to account for local traffic patterns, traffic periods were extracted from the local transportation plan, which are shaped by factors such as travel demand, opening hours, and work shifts of large employers. We then introduced a dummy for periods of *low traffic* intensity.

4.3 Analysis Method

We employed multivariate OLS regression to analyze whether the treatment affected the celeration profile of a trip. To ensure that any observed changes in celeration behavior were indeed prompted by the introduction of the bonus system, we had to address several empirical challenges. First, despite including several control variables, our estimations could be affected by significant differences between the treatment and non-treatment groups. To account for this, we used propensity score matching (PSM) to pair the trips in our treatment period with a control group of trips that is similar regarding driver, trip, weather, and traffic conditions. PSM is often used to alleviate potential biases arising from dissimilarities between treatment and non-treatment groups (e.g., Shipman et al. 2017). A probit regression was used to estimate the probability (i.e., the propensity score) of a trip being conducted in our treatment period based on our controls. Then, each trip within our treatment period was matched to a trip from the non-treatment period with the closest propensity score. To reduce the likelihood of poor matches, we did not allow the distance between the propensity scores (i.e., caliper) of the matches to exceed 1% (e.g., Hong et al. 2016; Shipman et al. 2017). As a result, we received a matched sample consisting of trips within our treatment period and a control group of trips that were conducted under similar conditions in the non-treatment period. Second, celeration behavior could also be influenced by driver-specific factors that are undetectable from an outside perspective. For example, some individuals may have a more aggressive driving style than others. To account for such driver-specific behavior, we further employed driver fixed effects regressions controlling for non-observable factors on an individual level. Fixed effects regressions are a common approach in empirical studies to address endogeneity issues arising from unobserved heterogeneity (e.g., Antonakis et al. 2010; Schall et al. 2016). Specifically, a fixed effect regression assigns an individual effect to each cross section (i.e., a specific driver) to control for unobservable factors, leaving only time-variant effects within a driver's celeration behavior to be estimated. This means that the driver fixed effects regression estimates change in the celeration behavior of a driver when the bonus scheme is introduced. Specifically, we used the following multivariate OLS regression model:

$$\text{Celeration}_{j,t} = \alpha + \beta(treatment)_{j,t} + \gamma(controls)_{j,t} + driver_j + \mu_{j,t}.$$

Besides our dependent, independent, and control variables, the remaining model items are the intercept (α), the driver fixed effects ($driver_j$), and the standard error term ($\mu_{j,t}$). Finally, we used Hubert–White robust standard errors and clustered them at the driver level to estimate our upcoming results.

5 Results

5.1 Descriptive Statistics

Our total sample consists of 2,983 trips, with 340 conducted in the treatment period and 2,643 in the non-treatment period. In contrast, the matched sample consisted of 566 trips equally distributed in the treatment and non-treatment periods. Table 2 displays the mean values and standard deviation for all regression variables of both samples. Moreover, we compared the differences between the means of the treatment period (with the applied bonus scheme) and the non-treatment period in Table 2. The results of this univariate comparison indicate a significant difference in the average celeration during the treatment and non-treatment periods for both the entire sample and the matched sample. The comparison also reveals several other significant differences in the controls between the trips in the treatment and non-treatment periods for the entire sample. However, no significant differences between the treatment and non-treatment periods of the matched sample were found. Hence, this univariate test provides initial indications that average celeration was lower in our treatment period. In addition to that, we checked the correlations between our regression variables. As some correlations between our control variables were relatively high, we computed variance inflation factors (VIFs) along the regressions. However, maximum VIFs were far below critical thresholds, indicating that our analysis was not constrained by multicollinearity.

Table 2 Descriptive statistics

Variables	Entire sample		Treatment period	Non-treatment period		Matched sample		Treatment period	Non-treatment period	
	Mean	SD	Mean	Mean	Diff.	Mean	SD	Mean	Mean	Diff.
Celeration	0.55	0.13	0.52	0.56	− 0.04***	0.53	0.13	0.52	0.55	− 0.03***
Bonus scheme	0.11	0.32	1.00	0.00	.	0.50	0.50	1.00	0.00	.
Gender (female)	0.27	0.44	0.34	0.26	0.08***	0.36	0.44	0.34	0.37	− 0.03
Experience	2.54	2.77	3.34	2.43	0.91***	3.38	4.16	3.49	3.27	0.22
Average speed	29.28	8.60	29.48	29.26	0.22	29.07	8.35	29.13	29.00	0.13
SOC	67.63	22.23	69.56	67.39	2.18*	70.21	20.97	70.30	70.13	0.18
(ln) distance	2.29	0.81	2.25	2.29	− 0.04	2.23	0.82	2.23	2.23	0.00
Low traffic	0.29	0.45	0.29	0.28	0.00	0.25	0.44	0.26	0.25	0.01
Holiday	0.14	0.35	0.25	0.13	0.12***	0.29	0.46	0.29	0.30	− 0.01
Weekend	0.26	0.44	0.24	0.26	− 0.03	0.19	0.39	0.19	0.19	0.00
Rain	2.09	4.67	4.72	1.75	2.96***	3.07	6.16	2.84	3.29	− 0.46
Snow	0.07	0.26	0.00	0.08	− 0.08***	0.00	0.00	0.00	0.00	.
Temperature	14.07	8.55	25.30	12.63	12.67***	23.77	5.00	23.92	23.62	0.31
Wind	35.49	16.84	41.36	34.73	6.63***	38.78	17.78	37.59	39.97	− 2.38
N	2983	2983	340	2643		566	566	283	283	

***, **, and * indicate significance at the 1, 5, and 10% levels (two-tailed), respectively

5.2 Regression Results

Table 3 depicts the results of our regression models. In all models, we ran OLS regressions with celeration as the dependent variable and bonus scheme as the independent variable while controlling for various confounding effects. We assigned Models 1 and 2 to the entire sample and Models 3 and 4 to the matched sample. Moreover, we included driver fixed effects in Models 2 and 4, whereas Models 1 and 3 were estimated without driver fixed effects. Thus, Models 1 and 3 indicate the cross-sectional differences of celeration behavior between the treatment and non-treatment periods, whereas Models 2 and 4 estimate the individual change in driver behavior caused by the bonus scheme treatment.

The results of Model 1 display a negative and statically significant coefficient ($p < 0.01$), indicating that celeration was lower in our treatment period while controlling for various confounding effects. Similarly, we find a negative and statically significant coefficient ($p < 0.01$) when we

Table 3 Regression results

	Model 1	Model 2	Model 3	Model 4
Sample	Entire sample	Entire sample	Matched sample	Matched sample
Method	OLS	OLS	OLS	OLS
Dependent variable	celeration	celeration	celeration	celeration
Independent variable				
Bonus scheme	**− 0.0387*****	**− 0.0258*****	**− 0.0279*****	**− 0.0198****
	(0.000)	**(0.000)**	**(0.006)**	**(0.049)**
Controls				
Gender (female)	− 0.0303*	–	− 0.0209	–
	(0.083)	–	(0.216)	–
Experience	0.0011	0.0021**	− 0.0014	0.0021**
	(0.690)	(0.011)	(0.286)	(0.026)
Average speed	0.0012	− 0.0002	0.0001	− 0.0002
	(0.210)	(0.497)	(0.922)	(0.837)
SOC	0.000	0.000	0.000	0.000
	(0.874)	(0. 568)	(0. 686)	(0.326)
(ln) distance	− 0.0627***	− 0.0439***	− 0.0472***	− 0.0419***
	(0.000)	(0.000)	(0.000)	(0.000)
Low traffic	− 0.0336**	− 0.0215***	−0.0400**	− 0.0337*
	(0.013)	(0.000)	(0.021)	(0.079)
Holiday	− 0.0189*	− 0.0171***	−0.002	− 0.0063
	(0.075)	(0.003)	(0.850)	(0.595)
Weekend	− 0.0031	− 0.0074	0.0038	− 0.0174
	(0.736)	(0.120)	(0.767)	(0.352)
Rain	0.0001	− 0.0006	0.0016*	0.0006
	(0.791)	(0.199)	(0.058)	(0.466)
Snow	− 0.0249***	− 0.0151**	–	–
	(0.003)	(0.025)	–	–
Temperature	− 0.0002	− 0.0002	−0.0031***	−0.0018
	(0.641)	(0.541)	(0.002)	(0.155)
Wind	− 0.0001	0.0001	−0.0006*	−0.0001
	(0.532)	(0.604)	(0.063)	(0.827)
Constant	0.6902***	0.6657***	0.7585***	0.6737***
	(0.000)	(0.000)	(0.000)	(0.000)
Driver fixed effects	No	Yes	No	Yes
N	2983	2983	566	566
Adjusted R^2	0.153	0.589	0.144	0.577

***, **, and * indicate significance at the 1, 5, and 10% levels (two-tailed), respectively. Standard errors are heteroscedasticity consistent and clustered at the driver level. *P* values are reported in parentheses include driver fixed effects in Model 2. Model 2 suggests that the individual celeration of a driver decreases during the treatment period. Specifically, drivers reduced their celeration behavior by 4.6% according to Model 2 (7.0% according to Model 1). The estimations on the matched sample further document that celeration is decreased by the introduction of our bonus scheme when compared to trips under similar conditions in the non-treatment period. Model 3 shows a negative and statically significant coefficient ($p < 0.01$), suggesting that celeration was 5.1% lower during trips in our treatment period. Moreover, we again find a negative and significant effect ($p < 0.05$) when we include driver fixed effects in Model 4, suggesting that drivers reduced their celeration profile by 3.6%. In conclusion, this consistent empirical picture among all regression models indicates that value co-capturing with consumers through bonus scheme mechanisms can mitigate reckless and wasteful driving.

6 Discussion of Empirical Findings

Our study sought to provide answers to the research question of how IS-enabled value co-capturing with consumers influences ABC in the case of carsharing. The empirical findings indicate that such an approach can foster sustainable consumer behavior. While it is difficult to assess the entirety of economic effects, our example business case analysis reveals that the potential savings are significant (see Appendix. for detailed description and calculation). Contingent on case-specific assumptions, a reduction in celeration behavior of 5.1% (the mean of all models included in Table 3) can yield annual savings between €2,404 and €5,855 (dependent on annual mileage). These findings indicate that tracking usage behavior and letting consumers participate economically when acting favorably can be worthwhile for ABC providers in various instances where economics depend on usage behavior (e.g., accommodation sharing, co-working spaces, collaborative tool or household device use). However, it is important to note whether consumer acceptance for these measures is potentially given in the specific context. Prior studies (e.g., Hildebrandt et al. 2015) have shown that this seems to be the case in carsharing, indicating the practicability of our approach. Furthermore, it must be mentioned that we selected one particular configuration for our experimental setting, though a range of options for business model design exists. Accordingly, despite the positive outcomes of our empirical approach, the payoff for a particular provider can be further improved and stabilized for ongoing viability through context-dependent selection of specific measures for practical implementation. We will elaborate upon two important aspects in the following.

First, regarding the design of specific value co-capturing mechanisms, the amount and distribution of the bonus payment can be varied. In our case we allowed all customers to participate directly in the savings captured from their individual behaviors. While this approach provides a transparent and simple mechanism, the possibility of low bonus payments for individuals can endanger ongoing consumer participation. An alternative way would be to redistribute the savings on a competitive basis via high scores or performance dashboards. Such "[t]ournaments can level the playing field for the agents" (Sappington 1991, p. 54), thus motivating consumers to outperform other community members. While requiring more coordination, these game elements enhance an individual's chances of achieving higher premiums, which may increase their long-term motivation and overall participation (Blohm and Leimeister 2013). Such an approach could thus further increase possible savings. However, if a provider wants to limit uncertainties and risks, it would also be possible to define a fixed amount in advance and reward it to those with the best performances. Note that either way, the logic of value co-capture entails that only savings realized through adapted consumer behavior may serve as the basis for bonus payments or other incentive types that are distributed among consumers. Another design option is related to the method of informing consumers about the evaluation of their behavior. In our case, we used the preexisting structure of the monthly invoice to give feedback to the consumers. An alternative, more costly way would be to install mobile devices in the cars and provide real-time feedback (Tulusan et al. 2012), which would encourage consumers to adjust their driving style more immediately. Ultimately, the specific configuration of value co-capture chosen should be adapted to concrete contextual circumstances and the available budget. Providers can then integrate valuable knowledge gathered in prior studies, e.g., in the areas of gamification (e.g., Bui and Veit 2015) or feedback systems (e.g., Loock et al. 2013; Tiefenbeck et al. 2016).

Second, when reflecting on value co-capturing with consumers in the context of smart and sustainable cities, providers should also be aware of the valuable side effects that their interventions may generate for the community, such as a reduction in pollution, congestion, and noise. This aspect creates windows of opportunity regarding the partner network of the provider's business model. One option for providers could be to find partners following a green strategy that might sponsor sustainable driving or issue non-monetary incentives, such as vouchers. This way, providers could increase bonus payments without investing themselves. A second option would be to partner with public authorities. The positive side effects represent fundamental benefits from a community perspective, given their targets of fostering a healthy and safe environment for its members (Corbett and Mellouli 2017). Therefore, as described by Cohen and Kietzmann (2014), local authorities, confronted with a variety of providers and without direct control and insight, might seek to foster such forms of sustainable business practice by granting subsidies, promotions, or other forms of support to providers incentivizing sustainable behavioral patterns. From a provider's perspective, this strategic support could enhance the overall benefit of employing measures of value co-capturing with consumers.

Summing up, providers implementing our approach in business practice might include different forms of awarding and distributing bonus payments, providing feedback, or monetary or non-monetary support from partners. These aspects can further increase the payoff as well as foster long-term sustainability. In the context of smart and sustainable cities, abstracting these thoughts on a holistic level shows that the scope must be extended beyond the consumer–provider dyad due to the potential externalities of consumption behavior involved (Firnkorn and Müller 2011). Individual, firm, and community perspectives, along with their idiosyncratic target system and agency, must be considered to understand the overall effects of such innovative measures. Not only are there positive effects emerging in consumer–provider relations, i.e., operational savings and rewards, but reduced celeration behavior also has an impact on a variety of aspects relevant to the landscape of modern cities, such as traffic flow consistency, CO_2 emissions, and noise (e.g., af Wåhlberg 2007; Kesting et al. 2008; Schall et al. 2016). Such measures can be seen as a form of public–private value co-capturing. From the perspective of local authorities, these "economic and noneconomic incentives to private operators may reduce agency conflicts and, as a result, improve overall system performance" (Cohen and Kietzmann 2014, p. 293). While Cohen and Kietzmann (2014) focus on the important aspect of ensuring sustainability by creating target congruity in inter-organizational relationships, such as public–private collaborations (i.e., local authorities and private solution providers), our study focuses on the consumer–provider dyad. Inspired by Lepak et al.'s (2007) multi-level view on value creation and capture, we synthesize the aforementioned thoughts in a multi-agent framework for smart city eco-system relationships in Fig. 3.

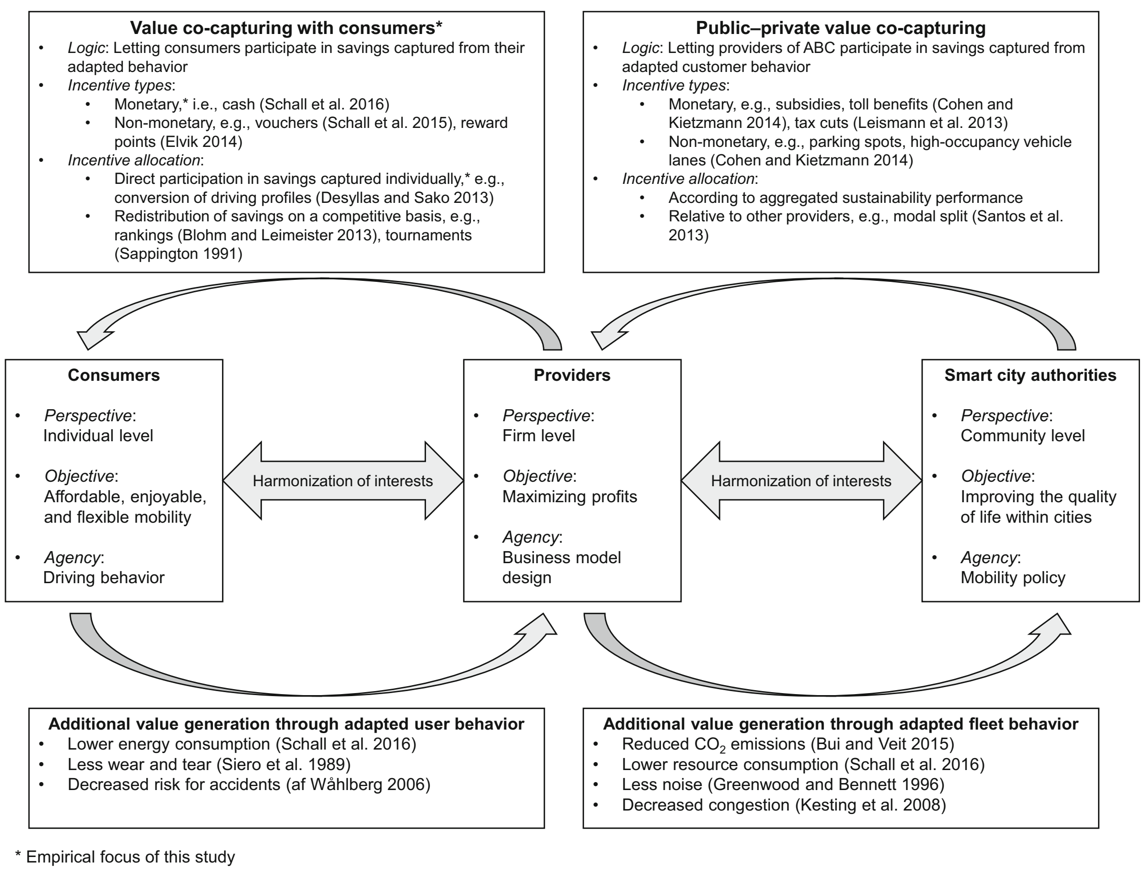

Fig. 3 Multi-agent smart city framework exemplified for the mobility domain

7 Implications

Our study has important implications for three specific streams in IS research. First, our study demonstrates the value of employing agency theory in modern ABC business models and their design, as agency conflicts are being reinforced in the digital era (Cohen and Kietzmann 2014). In the case of carsharing, the usage fee typically depends on time, distance, or a combination of both. Hence, consumers save money by reaching their destinations as fast as possible. According to agency theory's assumptions of bounded rationality and self-interest, this can compel carsharing users to exhibit reckless and wasteful driving behavior. Therefore, operators include additional operating costs and risks in their service fees, resulting in a loss of welfare for the paying carsharing community and hindering its expansion. We contend that these phenomena stem from an imbalance in business model designs that account for an empowered consumer (Lucas et al. 2013) with regard to value creation by building upon value co-creation (Lusch and Nambisan 2015) but, by refraining from value co-capturing with consumers, fail to do so for the case of value capture. However, achieving viability in digital business eco-systems (El Sawy and Pereira 2013) as contexts of joint collaboration "depends on creating an alignment of partners who must work together" (Adner 2012, p. 4). When the incentive structure allows for the behavior of one party to harm the overall value captured without consequences, this condition is violated. From this, we derive two important implications: First, consumers and any other entities must be regarded as integral parts of digital business eco-systems, especially in modern forms of ABC, as their behavior is important for its overall success. Second, this can only be achieved by applying mechanisms of value co-creation and co-capture simultaneously. With our empirical study, we provide fruitful insights on how IS can enable new means of value co-capture by sharing benefits with consumers, thus increasing the sustainability of ABC business models. While recent IS research has pointed to value co-capturing via sharing economic returns as a characteristic of digital business eco-systems (e.g., El Sawy and Pereira 2013), existing case studies on IS-enabled value co-capture predominantly characterize such mechanisms in corporate or intra-organizational contexts (e.g., Bharadwaj et al. 2013), where decisions are made at least in part heteronomously (Hess et al. 2014). However, as these usage contexts differ significantly from private contexts in which users decide themselves, existing theories cannot simply be adapted without verification (Hess et al. 2014). This study therefore focuses on the consumer as a partner in capturing value due to the direct influence of their behavior on the sustainability of ABC as well as their central importance in digital business models that emphasize customer experience (El Sawy and Pereira 2013).

Second, with this view, we contribute to the important endeavor of regarding smart cities as collaborative communities (Snow et al. 2016) in which not only actors such as firms and other institutions but also citizens must interact to drive the cities towards increased economic, environmental, and societal sustainability (Almirall et al. 2016). By nature, smart cities rely on closely intertwined digital, social, and physical infrastructures (Yoo et al. 2010) allowing for voluntary use of a rich and diverse set of offerings. While pervasive connectivity and the openness of digital business eco-systems (El Sawy and Pereira 2013) enables collaboration among various actors to develop innovative solutions aimed at growth and well-being (Snow et al. 2016), these services must also be consumed responsibly and sustainably. Our study contributes to smart city research by conceptualizing and empirically demonstrating a specific mechanism to foster sustainable resource use by the individual. This mechanism extends far beyond the particular instance of carsharing, applying to various other application fields in which agency relationships occur. Examples such as co-working spaces, shared accommodations, collaborative use of household appliances (e.g., washing machines), and diverse forms of shared mobility (e.g., bike sharing) reveal both how instances of ABC cater to almost every major theme of modern life and the direct influence of consumer behavior on the sustainability of these business models. Accordingly, contributing to more careful usage behavior in ABC becomes an increasingly important element in the realization of smart city visions.

This aspect points to our third major contribution. We contend that, whereas the high costs and effort required limited the lucrative application of countermeasures for agency conflicts in the pre-digital era (Sappington 1991), digital technologies can now significantly reduce the cost–benefit ratio. Extant literature has investigated IS interventions on consumer behavior via the application of intrinsic motivation, such as gamification or feedback systems (e.g., Loock et al. 2013; Bui and Veit 2015). Our study extends this view by exploring the emerging possibility of employing IS to monitor usage behavior and letting consumers participate in the savings realized. The findings demonstrate how digital technologies and their incorporation in proper business models can contribute to decreasing moral hazard when accessing shared goods, thus creating a welfare gain for all parties involved. By doing so, a more careful and resource-efficient user behavior can be achieved – just as would be the case if consumers owned the shared goods. Hence, IS-enabled value co-capturing with consumers could become a powerful means of creating target congruity within the collaborative community that constitutes a smart city (Snow et al. 2016), as consumers' self-determined choices concerning the adoption or non-adoption of existing solutions as well as their consumption behaviors may have large effects on the sustainability of the overall system. It is this very context – the freedom to draw from a range of sustainable and unsustainable offerings and behaviors, along with the current transformational state from established to smart and sustainable cities – that renders other strategies of pure monitoring, penalties, and exclusion particularly dangerous (Dyal-Chand 2015). Feelings of surveillance, control, and constrained agency might steer individuals away from considering ABC business models in the first place and thus hinder the transformation to smart and sustainable cities. Therefore, surrogating for ownership through value co-capturing is an important new facet in research about IT-enabled mitigation of moral hazard. However, our approach should be considered as complementary to other mechanisms such as gamification or feedback systems, as these measures could be used in combination. As a further contribution, we illustrate a way to evaluate the effectiveness of the options available (see Appendix) to select the most suitable portfolio of measures in a specific case.

Aside from these contributions to IS research, our study provides valuable implications for business practice. The investigation highlights the danger of moral hazard as an unwanted side effect occurring in various forms of ABC. We present a solution approach that builds upon digital technologies and emphasizes the importance of regarding consumers as active participants in value creation and capture. By tapping the in-vehicle digital systems of our test vehicles, we were able to precisely observe and measure usage-related metrics in carsharing operations. When digital technologies such as sensors and processing or communication technologies are embedded into everyday artifacts (Yoo 2010), they enable the digital capture of valuable usage data (Stocker et al. 2017). Thus, for the first time, tracing service usage and measuring behavior on an individual level (Agarwal and Dhar 2014) have become possible. However, our study goes beyond the mere analysis of service usage for, e.g., optimizing the economics of the service; instead we used the data proactively to engage with consumers by informing them about and rewarding sustainable usage behavior. This approach, in the spirit of "sense-and-respond" (El Sawy and Pereira 2013), makes more active use of the possibilities afforded by digital technology diffusion for business model innovation than prior forms of business intelligence and data mining have done. Our findings indicate that ABC providers should use digital technologies not only to enhance their value propositions, i.e., by offering convenient and flexible services, but also to co-capture value, i.e., sharing benefits with consumers to enhance the sustainability of their businesses.

8 Limitations and Future Research

Like every empirical investigation, our study is not free from limitations. First, studies in real-life conditions present a threat of low controllability of external factors (Harrison and List 2004). Although we included driver fixed effects, PSM, and a broad set of control variables, the existence of other varying factors that influence driving behavior cannot be completely ruled out. Nevertheless, these potential omitted variables would only cause endogeneity if simultaneously correlated with celeration behavior and our independent variable bonus scheme treatment (Antonakis et al. 2010). Hence, the threat from such an omitted variable remains rather limited. Second, conducting our study in a specific research setting with a limited treatment period and a particular configuration of value co-capturing limits the generalizability of our findings. Third, due to data privacy concerns, the variables included in our model were limited. Without elements such as in-depth user-related metrics, we were unable to study the underlying interrelations in greater detail by, e.g., evaluating the effects of value co-capture on an individual or group level to evaluate the type of customers who were particularly susceptible to enforcement mechanisms.

With our view, we extend emerging thoughts on the elaborated role of the consumer in digital business (Lucas et al. 2013) towards becoming an integral partner in value creation and capture – also in offline contexts of individual personal life (Hess et al. 2014). An important avenue for future works is to test the impacts of different value co-capturing mechanisms to find ideal configurations and optimize the outcomes. Although we specified our investigation for the case of carsharing, we believe that it provides a valuable theoretical and methodological foundation upon which future research can build. Therefore, we encourage IS researchers to further examine the interesting perspective of IS-enabled value co-capturing with consumers and challenge our findings. As more and more aspects of everyday life allow for the digital collection of data on individual behavior (Agarwal and Dhar 2014), the application possibilities for value co-capturing with consumers rise inexorably. Therefore, the concept of value co-capture could be transferred to various other domains with agency relationships, such as different instances of ABC (e.g., shared accommodations, work spaces, tools) or other contexts in which consumer behavior has a direct influence on the sustainability of the respective service or the overall system in which it operates. Previous research has, for instance, described the emerging possibilities of employing connectivity and real-time data to enable intermodal mobility solutions involving various means of transportation, such as public transit, taxis, and multiple forms of shared mobility solutions (e.g., Willing et al. 2017). Multimodal mobility platforms allow consumers to choose and combine various alternatives. However, from a collective perspective, their choices might hinder the efficiency and longevity of individual or collective initiatives (Cohen and Kietzmann 2014). Thus, IS-enabled value co-capturing with consumers might become an increasingly important component in future transportation systems and other smart city contexts.

9 Conclusion

Due to their superior utilization of resources, IS-enabled ABC business models represent an important building block for the transformation of cities towards increased economic, environmental, and societal sustainability. However, there are also negative side effects to these business models, i.e., careless or wasteful user behavior, that could hinder their enduringly profitable large-scale provision and thereby any potential environmental and societal gains. Our study emphasizes the danger of moral hazard as a negative and unwanted side effect resulting from the IS-enabled decoupling of ownership and use, which can be explained by the well-established agency theory. Prior research has demonstrated that consumers are becoming co-creators of value, which highlights the importance of viewing them as collaborative partners. However, value capture had not yet been adapted to such an elaborated view on the consumer in terms of enhanced responsibility and agency. Therefore, we investigated the potential of IS to mitigate moral hazard in carsharing – as a representative of ABC business models – by co-capturing value with consumers. More specifically, we modified the existing carsharing business model by implementing an IS-enabled bonus scheme system that significantly motivated consumers to reduce reckless and wasteful driving. We thus provide important implications for IS research on the sustainable viability of digital eco-systems.

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