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The Light and Dark Side of the Black Box: Sensor-Based Technology in the Automotive Industry

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Abstract:

Sensor-based technologies are increasingly integrated into diverse aspects of our everyday lives. Despite the importance of understanding how these technologies are adopted and exploited by businesses and consumers, the information systems (IS) community has thus far devoted relatively little attention to the topic. Accordingly, our objective in this paper is to foster an exploration of the issue amongst IS scholars by focusing on the emergent use of sensor-based technologies in the automotive insurance industry. Insurance providers are increasingly turning to such technologies to gain competitive advantage around risk assessment and behavior-based pricing. To investigate this phenomenon, we consider the experiences of two organizations operating distinct national contexts – Progressive Insurance (US) and Generali (Italy). These two insurance providers have been first movers in the adoption of sensor-based technologies for risk assessment and policy pricing. First, we highlight the key similarities and differences between the cases with regard to the technologies adopted, business models pursued, and anticipated benefits and pitfalls for the companies and their consumers. Second, in a more holistic way we discuss the implications and unintended consequences of sensor-based technologies in the automotive insurance industry. We formulate several research questions that will provide opportunities and encourage more research in this emerging area of study.

Keywords: sensor-based technologies, automotive insurance companies, big data, little data, ethical issues

UNCORRECTED PROOFS

1 Introduction

Sensor-based technologies increasingly pervade the objects we use in our work and private lives (Andersson et al., 2008; Jonsson et al., 2009; Lindgren et al., 2008). These technologies pose opportunities and challenges for individuals, businesses, and society (Loebbecke & Picot, 2015). In this paper, we call for expanded information systems (IS) research on the implications of growing adoption of sensor-based technologies. While considering the relevance of these technologies in a variety of industries, our present exploration focuses largely on illustrative developments in the automotive insurance industry. Automotive vehicles have been highlighted as a critical domain in the broader contexts of embedded computing (Aoyama, 2012), geographic information systems (Miller & Shaw, 2001), and ubiquitous computing (Henfridsson & Lindgren, 2005). In this position paper, we outline the strategic and operational decisions of automotive insurance providers regarding sensor-based technology adoption, with an eye to the practical and ethical implications of the resulting business models. In particular, after providing a high-level overview of how sensor-based technologies have been studied in IS and related research disciplines, we delve into the emergent pay-as-you-drive (PAYD) business model, which has now been adopted by several automotive insurance companies worldwide. In the PAYD approach, insurance pricing is at least partially based on the actual driving behaviors of policyholders (e.g., mileage driven, average speeds, takeoff and braking behavior) as captured by sensor devices (Händel et al., 2014; Parry, 2005). This IT-enabled business model has significant strategic implications, including the self-selection of 'good' drivers (i.e., drivers who believe they could benefit from a premium discount because they will 'look good' when their driving data is monitored) and the provision of new services that leverage a vehicle's sensor-based technologies.

With the emergence of novel business models grounded in sensor-based technologies, we contend that it is important to address both the business opportunities and societal implications (including potential unintended consequences) associated with collection of massive amounts of data on private citizens. As the automotive insurance context illustrates, the expanded use of sensor-based technologies raises significant implications at individual, organizational, and societal levels of analysis across diverse sectors and spheres of life. At the individual level, the adoption of these systems may significantly personal behavior patterns and management of personal information). At the organizational level, these technologies create opportunities for business model creation and risk assessment. Finally, at the societal level, adoption has long-term implications for public welfare and privacy protection.

We lay out the above issues and identify critical research questions posed by this emergent IS domain. To support these reflections, we consider the experiences of two early-adopters of sensor-based technology within the automotive insurance industry in the United States (Progressive Insurance) and Europe (Generali Italia). By comparing and contrasting the approaches of these firms, we identify facets of the business opportunity associated with sensor-based technologies as well as the ethical questions raised by their adoption – both within and beyond the automotive insurance context. Given the diversity of sensor applications, we consider the implications and ethical issues arising from the intensive use of these innovative and powerful technologies. Building on this, we conclude our discussion by proposing future avenues of research which stem from our assessment of the automotive insurance industry and embrace a wider range of contexts where sensors are diffused, have affected established business models, and might pose societal concerns.

2 Automotive Insurance and Sensor-Based Technologies

2.1 Sensors

Sensors are devices that enable the conversion of physical phenomena into electronic signals (Fraden, 2004; Kenny, 2004). Sensor-based technologies are increasingly studied under the broad umbrella of the 'Internet of Things' (IoT), which is defined as "a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies" (http://www.itu.int/en/ITU-T/gsi/iot/Pages/default.aspx). Sensor technologies are present in and affect a wide range of industries and societal contexts. Examples include production process monitoring devices (Westergren & Holmstrom, 2012; Westergren & Wennerholm, 2014), healthcare (Zhang et al., 2012; Pantelopolous & Bourbakis, 2010), urbanization and infrastructures (Hancke et al. 2013; Li & Fu 2011), agriculture and food production

(Mainwaring et al. 2007;Ruiz-Garcia et al. 2009), military and crime prevention (Duisic et al. 2012; Mylonas et al. 2013), and environmental issues such as habitat monitoring, ecology studies, and weather forecasting (Muller et al. 2013; Szewczyk et al., 2004; Wilson et al. 2015)[1].

In light of the large number of practical domains impacted by sensor-based technologies, it is perhaps not surprising that research on these IT artifacts reflects diverse perspectives and a wide range of scholarly disciplines. In addition to multiple engineering domains, several social science fields have considered the practical and theoretical implications of sensor adoption. In sociology, researchers have explored the ways in which sensor-based technologies are changing our modes of interaction and fundamental perspectives on social systems (Castells et al., 2009; Van Dijk, 2012), with a particular emphasis on the role of sensors in social surveillance (Bauman & Lyon, 2013; Lyon, 2014). Applications in psychology have focused on new avenues for psychological treatment (Clough & Casey, 2015; Luxton et al., 2011) and uses of sensor technology for the conduct of psychological research (Miller, 2012). In human-computer interaction (HCI) studies, sensor-based technologies have been the focus of research on gesture recognition (Benoit et al., 2003; Lyons et al., 2007), wearable devices for remote health monitoring (Patel et al., 2012; Son et al., 2014), and smart home systems (Kühnel et al., 2011).

Within the IS literature, research on sensor-based technologies has largely been pursued in the context of ubiquitous computing (Lyytinen & Yoo, 2002a; Weiser, 1991). In particular, many of the early discussions of ubiquitous computing architectures called attention to the combined potential for new work processes and threats of social disruption inherent in the adoption of sensor technologies (Andersson & Lindgren, 2005; Jessup & Robey, 2002; Lyytinen & Yoo, 2002b). In this paper we build on previous research and we do so by focusing on sensor-based technologies in the automotive insurance industry, where such technologies are increasingly prominent in the pricing and provision of automotive insurance. In a move that mirrors sensor adoption in automotive manufacturing (King & Lyytinen, 2005), auto insurance providers have experimented with the use of sensor-based systems as part of the PAYD model of insurance provision (Boquete et al., 2010; Coroama, 2006; Troncoso et al., 2011). As with other types of insurance, the essential characteristic of automotive insurance is the pooling of risk across a large number of policyholders (Desyllas & Sako, 2013; Harrington & Doerpinghaus, 1993). Specifically, automotive insurance providers collect fees (premiums) to cover the losses experienced by a subset of policyholders. To assess the risks of loss, insurance providers have traditionally focused on the segmentation of policyholders into driver classes, generally based on demographic (e.g., age) and behavioral (e.g., driving record) factors (Green, 1977; Harrington & Niehaus, 1998). The introduction of the PAYD model represents a significant break with this segment-oriented approach. Rather than analyzing categories of policyholders, PAYD insurance implies pricing based on observable driving behaviors with known risk profiles.

This shift in focus with the PAYD model implies the necessity of tremendous data collection by insurance providers (Desyllas & Sako, 2013). Specifically, vehicles must be equipped with, or connected to, technologies that can collect such risk-related factors as vehicle speed, rapid acceleration/deceleration, impact occurrences, time of day driven, and vehicle location. The PAYD programs currently in place use variable assortments of onboard sensors, wireless communications, and global positioning system (GPS) components (Händel, et al., 2014; Hossain et al., 2010; Yoon et al., 2008). The most widely-adopted approach centers on the use of a “black box” unit – a device which integrates with a vehicle’s onboard diagnostics (OBD) system to record and transmit data on vehicle operation (Filipova-Neumann & Welzel, 2010; Troncoso, et al., 2011). In some PAYD implementations, this sensor-based system is used in tandem with GPS to determine vehicle location and adherence to posted speed limits. While the specific technologies employed vary, the IT-intensive nature of the PAYD model is universal.

2.2 Novel Business Models and Their Impact to Society

A business model involves “defining the manner by which the enterprise delivers value to consumers, entices consumers to pay for value, and converts those payments to profit” (Teece, 2010, p. 172). While a strong business model can be associated with any long-term successful venture, the term itself has only risen to prominence relatively recently (Magretta, 2002; Seddon et al., 2004). Indeed, the use of the term ‘business model’ is closely tied to the growth of the Internet and contemporary computing environments (Osterwalder et al., 2005; Seddon, et al., 2004). This association underscores the fact that the pursuit of innovative business models has increasingly been tied to the exploitation of IT resources (McGrath, 2010),

[1] For a comprehensive review of domains that relate to sensor technologies, see Rawat et al. 2014

whether through the novel application of well-established technologies (Gambardella & McGahan, 2010) or the pursuit of first-mover advantage through cutting-edge IT (Chesbrough, 2010; Wirtz et al., 2010).

With the dramatic explosion of interest in big data phenomena (Kallinikos & Constantiou, 2015; Woerner & Wixom, 2015) in recent years, we have witnessed the emergence of several novel business models relying on sensor technologies. Westergren and Holmström (2012) describe the leveraging of sensors and other IT resources to foster an open innovation model (Chesbrough, 2006) in the ore mining industry. Similarly, Coye et al. (2009) explore sensor-driven business model innovation in the healthcare sector, where remote patient management processes have shifted roles and responsibilities between traditional providers (i.e., hospitals), non-clinician providers, and patients themselves. Appari and Johnson (2010) suggest that sensors might lead to reducing the use of healthcare revenues for emergency departments and skilled nurses facilities, while investments in business continuity and information security are becoming key assets.

In this vein, the PAYD model provides a valuable context for exploring the business and societal implications of technology-enabled business model innovation (Loebbecke & Picot, 2015; Markus, 2015; Newell & Marabelli, 2015). A focus on sensor adoption and use in the automotive insurance industry is relevant because it is driving a variety of changes affecting organizations and individuals across the automotive sector and beyond, including auto manufacturers, automotive sensor and OBD technology makers, automotive maintenance services, financing entities, information security standards, and public policy makers. Most fundamentally, the PAYD model is disrupting the way insurance companies assess, understand, and price risk and in turn set customers' premiums. In terms of the strategic implications for businesses, the PAYD model is heralded as a significant advancement for the auto insurance marketplace, offering financial advantages to both consumers and insurance providers. From the consumer perspective, PAYD insurance promises to increase the affordability and equitability of coverage, as premiums are based on actually driving behavior rather than demographic characteristics and past events (Bordoff & Noel, 2008; Litman, 2011). For insurers, the PAYD model increases visibility of driver behavior, enhances the ability to price risk, and fosters better driving behavior among policyholders (Desyllas & Sako, 2013; Westerman et al., 2014).

In terms of the ethical implications, PAYD models may have significant societal benefits because of the incentives to eliminate unnecessary driving, thereby reducing traffic congestion, accident risk, and fuel consumption (Bolderdijk & Steg, 2011; Parry, 2005). At the same time, the PAYD approach may represent an inherent threat to personal privacy (Troncoso, et al., 2011). Unfortunately, the tradeoffs between the purported advantages of this innovation and the ethical implications that it engenders have received limited research attention, especially from the IS community.

3 The Pursuit of PAYD: Two approaches

To explore the phenomenon of sensor-based technology adoption in the PAYD insurance model, we consider the appropriation of such technologies by two early-adopting firms operating in distinct markets. Specifically, we provide an overview of how two prominent automotive insurance firms in Europe (Generali Italia) and the United States (Progressive Insurance) have strategically adopted PAYD provision. Importantly, we develop this juxtaposition to highlight the range of questions that arise with the formulation and implementation of the PAYD business model, rather than to pursue formal case analyses of the two businesses considered.

3.1 Method

While the focus of the present discussion is the articulation of prospective research streams rather than empirical research findings, we do want to note the sources of information upon which we draw. Multiple modes of data collection were pursued, including interviews, secondary data and documentary review, and direct observation of technology use. The company inquiries included an exploration of the firms' histories, current operating environments and business processes, the nature of the underlying technologies, and the perceived benefits for both the companies themselves and their consumers.

The preliminary exploration of the two organizations was based on secondary data, including company documentation and external reports on sensor adoption within the two firms.[2] While some argue that secondary data represents a substitute for 'more expensive' but better primary data (Cowton, 1998), others note that secondary data can provide some distinct advantages. For instance, Harris (2001) suggests that secondary data help to provide a holistic and complete overview of a body of knowledge, such as that involving a market, an industry, or large organizations that make information available to the public (e.g., shareholders). Moreover, secondary data minimizes social desirability response bias (Harris, 2001). Finally, secondary data collected from different public sources can be triangulated and merged to create an authentic 'story' (Insch et al., 1997).

To deepen our understanding of PAYD initiative within the two companies, we also conducted interviews with top-managers and executives at both firms. We conducted a total of 12 interviews (six at each firm) with seven individuals (four from Generali, three from Progressive). We were able to interact with the company representatives both before and after our secondary data collection. The interviews with the companies' managers and executives provided insights on technical characteristics of their PAYD services and the rationale behind their strategic choices. The two modes of data collection together enable us to compare and contrast the underlying business models employed by the businesses.

The comparison of the approaches pursued by the firms affords us a rich exploration of this emergent phenomenon (i.e., the sensor-enabled PAYD model) which has received limited research attention. Although we do not aim to draw region-based generalizations, we focus on firms in two substantively different market contexts to enable a juxtaposition of U.S. and European approaches to the phenomenon. Our inquiries into the firms have focused on an exploration of the company histories, current operating environments, business processes, the nature of the underlying technologies, and the perceived benefits for both the companies themselves and their consumers. Before delving into the strategic and ethical implications raised, we provide an overview of the two companies, highlighting the underlying sensor technologies and the benefits they may present to both the companies and their consumers. We also provide a comparison of the two companies and point to overlaps and differences in terms of their ability to explore and exploit sensor technologies.

3.2 Generali Italia (EU)

Generali Italia is the principal operating company of Generali Group, a leading player in insurance and financial markets around the world (https://www.generali.com/generalicom/). Operating in more than 60 countries, Generali Group focuses primarily on the life insurance segment. However, the firm's non-life segments (including automotive, home, and health insurance) have become increasingly prominent. Generali Italia (hereafter, Generali) is a publicly-traded firm headquartered in the northeastern Italian city of Trieste. The firm has a prominent role in the financial industry in Italy. In 2013, Generali Italia enjoyed the second largest share of Italian insurance market in both the life (15.1%) and non-life (18.1%) product segments (Zanghieri, 2014). With more than 10 million policyholders and 7,200 employees, Generali relies on a salesforce of 3,200 agents and more than 21,500 sub-agents. In the automotive insurance segment, Generali has placed a significant emphasis on the adoption of black box telematic technologies. This product has been launched in collaboration with Generali's sister-company Genertel, an online insurance company owned by the Generali Group. Generali's proactive adoption of black-box innovation has been driven by both consumer/market conditions and regulatory factors.

3.2.1 Underlying technology and information collected

Generali's approach to PAYD centers on the adoption of a sensor-based OBD device, which is capable of recording several significant details of driving behavior. The device is equipped with a GPS system and a subscriber identification module (SIM) card that transmits data on a daily basis to a third-party telematic service provider (TPS) data center. The TPS transmits a summary of the data collected to Generali on a monthly or even daily basis. The data collected includes details on acceleration/deceleration, speed traveled, vibration, and impact events. Interestingly, in case of an accident (i.e., detected as an abnormal deceleration or an impact), the data is transmitted to the TPS and on to Generali immediately. Emergency services are automatically alerted and given the GPS location of the insured vehicle. In case of a car

[2] Main documents accessed and analyzed include the companies' website, press releases, contracts providing the PAYD service description, various research and position (white) papers, and slides of presentations given by the companies' executives that are related to the strategic implementation of PAYD services.

accident that does not involve emergency services (i.e., not detected by the OBD device), Generali might ask the TPS for specific data (e.g., time of day, GPS coordinates) in an effort to address potential ambiguities surrounding the accident or the possibility of fraudulent claims. Once a policyholder opens a claim, Generali requests data such as date, location, speed, and impact indications of the vehicle. If the information provided by the TPS is inconsistent with that provided by the policyholder, Generali may initiate antifraud procedures. According to top management at Generali, in 2014 one of the most relevant advantages associated with their PAYD model was the ability to quickly investigate potential fraud incidents.

The business model adopted by Generali reflects a clear demarcation of roles and responsibilities for the various institutional parties involved with the sensor-based technology employed to support the PAYD model. The IT elements involved (i.e., OBD, GPS, SIM card, and data center) are wholly-owned by the TPS. Thus, Generali has fully outsourced the telematics service. Generali then uses the data collected through the telematics service to evaluate driver behavior, assess risk profiles, and determine policyholders' premiums. If the algorithm that Generali uses to identify good and bad drivers changes and Generali determines that additional data is needed to appropriately assess driver behavior, a revised agreement must be established with the TSP in order for Generali to acquire additional data. In short, the TSP sells data at a flat rate to Generali – but only a certain amount of data and on a pre-established basis. Figure 1 shows the sensor-based technology and underlying processes that support Generali's strategy.

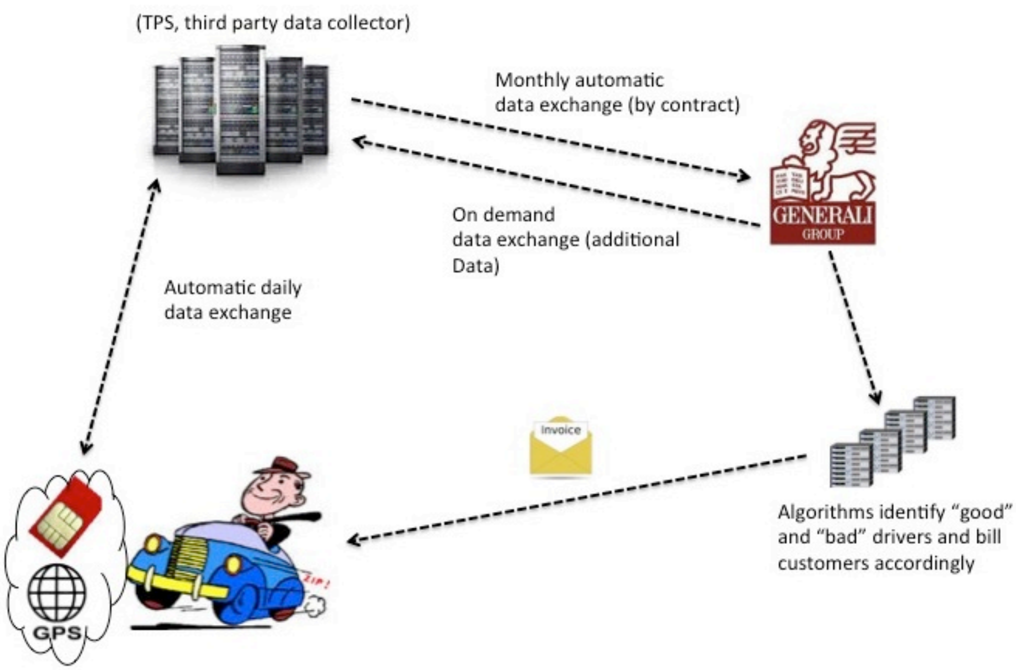

Figure 1. Generali's PAYD Model, Technology and Processes

3.2.2 Benefits for consumers

The black box technology offers a number of purported benefits for Generali's consumers. Most notably, consumers experience lower rates if their driving styles are deemed to be 'good' according to the algorithmic analysis. In addition, Generali sends a monthly report with key indicators of consumers' driving behavior, such as occurrences of rapid deceleration (i.e., hard braking suggestive of attention concerns) or instances of driving over the speed limits. These reports are meant to provide feedback to the consumers, enabling them to 'learn' how to drive more safely and accordingly reduce their insurance premiums and increase their security. Finally, the consumers benefit from the ancillary services related to the telematics data (outlined in the contracts) such as roadside assistance, automated notification of emergency services, and assistance in carjacking incidences.

3.2.3 Benefits for Generali

According to an interview conducted with a strategic marketing manager, Generali has identified three primary benefits that the telematics technology. First, most good drivers choose to have an OBD, because they know that they will save money, thus creating a self-selection mechanism for lower-risk drivers. If they are able to retain these responsible consumers, early adopters such as Generali will on average have better drivers than their competitors, thereby enhancing profits. Secondly, the black box technology enables Generali to sell more insurance policies, because of the ancillary services provided. Finally, the telematics technology dramatically enhances Generali's fraud detection capabilities, by expanding the evidentiary base available for analysis[3].

3.3 Progressive Insurance (US)

Headquartered in Mayfield Village, Ohio, United States (https://www.progressive.com/progressive-insurance/company-introduction/), Progressive Insurance is the country's fourth largest automotive insurance provider, with over 15 million active policies and over eight percent of the national market share. The firm offers coverage for a wide range of vehicle types, including personal and commercial autos, motorcycles, recreational vehicles, and boats. Progressive sells policies and interacts with their consumers on multiple platforms. In its rise to the top ranks of the U.S. automotive insurance marketplace, Progressive has gained a reputation for both process and technological innovation. The firm made early use of databases to conduct more fine-grained analysis of accident and client data than its competitors, enabling Progressive to profitably serve the non-standard market. In the late 1980s, Progressive invested heavily in its information infrastructure, installing a large computer system to accelerate both claims and application processing. This investment resulted in fewer inaccurately priced policies and enhanced the productivity of claims adjusters. In the 1990s, the company embarked on a number of innovation initiatives, including the introduction of comparative pricing (i.e., providing prospective consumers with quotes from Progressive and up to its three competitors), the development of a mobile claims processing process, and the launch of the industry's first commercial web site (Hansen & Vandenbosch, 2005).

More recently, Progressive has become one of the first U.S.-based insurance companies to adopt the PAYD model. The primary focus of Progressive's current PAYD initiative is a program called Snapshot (http://www.progressive.com/auto/snapshot/). Snapshot is a small sensor-equipped device as well as voluntary discount program which enables drivers to reduce their premium payments by sharing driving data with Progressive. Originally piloted in 2003 (then under the name TripSense), Progressive rolled out Snapshot in earnest beginning in 2011.

3.3.1 Underlying technology and information collected

At the heart of the Snapshot program is the Snapshot device, a small piece of hardware that is plugged into the OBD port located under a vehicle's dashboard. The device records data on several key aspects of driving behavior, including time of day driven, vehicle speed, and rapid acceleration and braking. The device transmits this data back to Progressive via an embedded wireless modem and malfunctions of the device are communicated to the driver in the form of email alerts. The earliest phase of Progressive's PAYD initiative incorporated a GPS component that contributed to a driver's profile. However, the GPS element was eliminated in 2011 in response to consumer privacy concerns. It was later partially re-introduced but its data is no longer used for making up a consumer's driving profile. Progressive's current privacy statement (https://www.progressive.com/auto/snapshot-privacy-statement/) asserts that "Snapshot devices that contain GPS technology record location information for research and development purposes." Other sources (press articles as well as and the Progressive customer service) suggest that consumers are not aware of whether their device is GPS-equipped, as Progressive explicitly declares that if a GPS is embedded in the Snapshot "we don't use it to calculate your rate" (https://www.progressive.com/auto/snapshot-common-questions/). While most of the technical characteristics of Progressive's PAYD system are similar to those of Generali, the former owns the whole IT infrastructure. Figure 2 highlights Progressive's sensor-based technology and underlying processes.

[3] More information can be found at http://www.genertel.it/assicurazioni/auto/quality-driver.html.

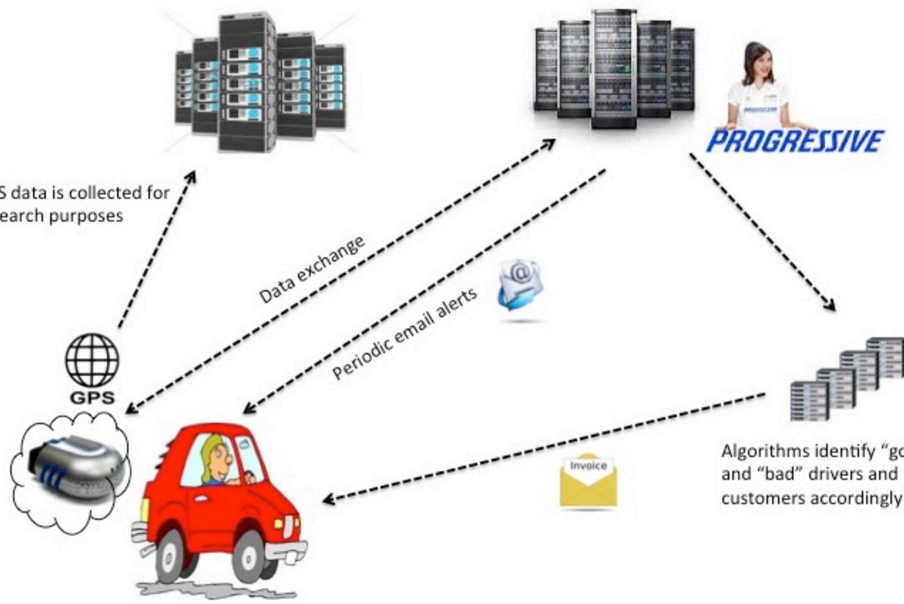

Figure 2. Progressive's PAYD Model, Technology and Processes

3.3.2 Benefits for consumers

The Snapshot program proposes to offer consumers greater control over the premiums they pay. Participation in the program is entirely voluntary and consumers can opt out of the program at any time. In terms of pricing, an individual's standard premium – i.e., the premium based on traditional underwriting inputs – acts as a baseline. By participating in the program, policyholders can receive discounts of up to 30 percent based on their driving data, but the average discount achieved is around 10 percent (Stross, 2012). In addition to the financial benefits, participation in the Snapshot program provides a consumer with greater visibility on their driving habits. After 30 days in the program, participants can log into Progressive's consumer portal to review the data gathered on their device. The company also provides tips for how drivers could enhance their discounts through safer driving behaviors.

3.3.3 Benefits for Progressive

The Snapshot program presents multiple benefits to Progressive. Most fundamentally, the collection of actual usage data holds the promise of greatly improving the assessment of risk. By knowing when a vehicle is driven, a vehicle's total time on the road, and specific driving behavior (e.g., frequency of hard braking), Progressive can more accurately price a driver's policy relative to the underwriting risk that he or she represents. In addition, by raising the visibility of risky driving behaviors among drivers themselves, the Snapshot program may prompt Progressive policyholders to engage in safer driving habits. Finally, the Snapshot program may enhance consumer satisfaction. Progressive's customer satisfaction ratings with respect to both pricing and policy offerings are significantly higher among Snapshot participants than among those not participating in the program (J.D. Power, 2013).

A comparison of the key features of the Generali and Progressive approaches is provided in Table 1.

Table 1: Generali and Progressive Approaches to Sensor-based Technology

PAYD Aspects	Generali Italia (EU)	Progressive (USA)
Underlying Technology	OBD (data collection); GPS (data collection); SIM Card (data transfer)	OBD (data collection) ; GPS (research data); Wireless modem (data transfer)

Data Collected	Acceleration/ Deceleration; Impact events; Vehicle speed; Vehicle-related information; Vibration; GPS location	Acceleration/ Deceleration; Device insertion/ removal; Time of day driven; Vehicle speed; Vehicle-related information
Business Model Elements	Outsourcing of technology ; Periodic access of basic data; On-demand access to extra data	Company-owned technology; Optional participation; Access to all data collected
Consumer Benefits	Lower premiums; Learning from reports on how to become a better driver (safety)	Lower premiums; Visibility of driving behaviors and tips on how to achieve a lower premium
Company Benefits	Self-selection of good drivers; Enhanced marketing of policies; Improved fraud detection	Self-selection of good drivers; Better risk assessment; Enhanced underwriting effectiveness
Privacy/ Regulatory Frameworks	Regulatory-based approach to privacy issues EU and country-level regulations on data protection and privacy Italian and European data protection authorities assist customers and monitor the insurers Forthcoming specific laws related to IoT data protection (2016) Privacy Officers competences certified by professional standards	Normative-based approach to privacy issues Federal and industry-specific laws, regulations and authorities (“patchwork system”) Federal Trade Commission (FTC) supervises and creates policies to enforce federal laws FTC reports on IoT due in 2016 Privacy Officers competences certified by professional standards

4 Emerging Issues in the PAYD Model

A comparison of project characteristics at Generali and Progressive reveals that the PAYD model may present a number of benefits for businesses and consumers alike. However, we contend that the benefits for insured the companies, drivers and society as a whole should be balanced with a consideration of potential unintended consequences that relate to the ethical implications of this technology use. In this section, we examine the various aspects of the two PAYD business models and their long-term sustainability. In the following section, we consider the tradeoffs between the business opportunities of the PAYD business models and the ethical issues affecting individuals and society.

4.1 General and Progressive: Is There a Winning Strategy?

Focusing on the comparison between the Generali and Progressive approaches, a number of strategic implications deserve attention. As we showcase below, while the literature provides a variety of frameworks for comparing the two models (e.g., vis-à-vis outsourcing and technology selection), big data analytics, algorithmic decision-making processes, and their applications to the automotive insurance industry represent a relatively unexplored context. Accordingly, we argue that this phenomenon poses a number of research questions (in the form of research question sets) which the IS community is well-positioned to tackle.

4.1.1 The Promise of Self-Selection

The Generali and Progressive models suggest a prominent common motivation for the adoption of an IT-enabled PAYD strategy – the promotion of safer driving behaviors based on monitoring. The fundamental argument behind both services is that consumers are more likely to engage in ‘good’ driving behaviors if they know that the insurance provider will monitor their driving data. Of course, this assertion rests upon an empirical question. Researchers should assess the extent to which the mere fact of monitoring can foster better driving behaviors. While research on social behaviors conditioned by constant monitoring shows mixed results in terms of the outcomes of such monitoring (Podsakoff et al., 1982; Staples, 2013), there is no empirical evidence about whether being monitored combined with financial incentives (i.e., the reduction of the insurance premium) leads to behavioral changes, especially in the long-term (Hasan &

Subhani, 2012). Prior research on monitored behaviors, should be applied to PAYD contexts, for instance by addressing the following questions:

RQ Set 1:

1a. To what degree does perceived monitoring influence the driving behaviors of policyholders?

1b. Do financial incentives (i.e., low insurance premiums) have the ability to alter driving behaviors in the long-term?

4.1.2 Switching Costs and Data Transparency

While both providers allow users to quit the program at any time, Generali's policy involves a fee for uninstalling the SIM-based OBD while Progressive's policyholders do not suffer any expense if they change their mind. Interestingly, both insurance companies built PAYD programs where the premium can only be reduced, not increased (e.g., based on evidence of risky driving behaviors). Representatives from both firms noted that this strategy is pursued to acquire the highest number of consumers, as there is no concrete risk of paying more (in premiums as least) because of subpar sensor data. Moreover, the reports provided by both companies are detailed enough to inform the consumers of how they are evaluated – for instance, these reports show for how long a car was driven in 'high risk' hours (12am – 4am, Progressive insurance) and the average speed on different types of roads such as highways, state routes, or city roads (Generali insurance). This can represent an important 'learning' moment for consumers who get to know how and why they are billed. Once the driving style is adapted to the parameters that an insurance company measures, the effort associated with such a change might lead consumers to stick with a PAYD-based provider. Overall, the possibility of premium reduction as well as the learning opportunities - for instance, on how to drive more safely while improving a driving style that promotes eco-efficient conduct of vehicles[4] - might create significant switching costs for policyholders, helping the providers to retain good drivers. In this regard, the Generali model may present an additional switching cost for consumers because the real time communication between a car's sensor system and the data center enables Generali to offer a range of ancillary services.

The question of data transparency poses a potential adverse effect for providers as well. The transparency created around how drivers are evaluated might lead to opportunistic behaviors on the part of policyholders (i.e., efforts to game the system). For example, a 'bad' driver might decide to drive (even recklessly) only in low risk hours and reduce sudden decelerations, with the result that the algorithm that interprets the data provides a positive evaluation of the driver, while the reality reflects the opposite (ironically, an algorithm might well be able to detect these attempts to game the system – yet these algorithms represent a source of competitive advantage and are not shared with the public). Moreover (and paradoxically), attempting to game the system can lead to a more dangerous driving style, for instance when a policyholder tries to limit sudden decelerations while driving recklessly. Interesting areas to explore thus include the following:

RQ Set 2:

2a. To what extent does PAYD-related data transparency influence the perceived switching costs of consumers?

2b. To what degree does PAYD-related data transparency engender efforts to game the system?

4.1.3 Real-Time Data Exchange

Generali and Progressive use IT-based sensors in very different ways. Generali's technology has the ability not only to collect but also process real-time driving data, engendering a variety of ancillary services associated with security, as we previously noted. Here we are interested in understanding the perceived value for consumers of real-time data. Marketing research has already made attempts to address this issue (e.g., Jones et al., 2005; Spiess et al., 2014). However, the IS community does not seem to have delved into the topic. Therefore, we propose the following research questions:

RQ Set 3:

[4] We thank an anonymous reviewer for this insightful suggestion

3a. What is the value of real-time data with respect to the services offered to consumers?

3b. Do driving behaviors change when data is captured and transmitted in real time?

4.1.4 Technology Sourcing and Data Ownership: The Analytics Outsourcing Dilemma

One of the most significant differences between the Generali and Progressive approaches relates to the control over the technologies that enable the PAYD model. Generali has fully outsourced the underlying sensor-based telematics to their TSP provider. In contrast, Progressive owns these elements and all of the data flowing from them. Advantages to the Generali approach include the ability to limit the costs associated with maintaining the technical infrastructure and to focus on existing areas of core competence, leaving ancillary functions to their strategic partners (Prahalad & Hamel, 1990). The corresponding limitation is that the firm’s full access to the data is constrained and the desire for additional data elements would necessitate ancillary fees.

In the Progressive approach, the advantage is the development of a vast data store subject to extensive analysis. With the explosion of big data analytics (McAfee & Brynjolfsson, 2012), access to such data holds the promise of future insights regarding the data points that are most relevant for risk assessment and pricing. While the literature clearly highlights pros and cons of strategic IT outsourcing (for a comprehensive review, see Lacity et al., 2009), research shows mixed results when discussing the outsourcing of big data analytics, because of the key strategic (and ‘predictive’) value of such algorithms (Chen et al., 2012; Schniederjans et al., 2014). More importantly, Generali’s outsourcing limits its control over the data collected and analyzed as they need to pay additional fees to obtain additional data. This strategic decision could conceivably present a challenge if PAYD systems become more widespread and the premium for reports that policyholders can require ‘on demand’ rises. In such a scenario, companies such as Generali would either have to buy a huge amount of analytics reports for each consumer (in the hope that consumers ask for some of the additional data) or try to develop analytics competencies in-house. This issue/tradeoff related to the outsourcing of analytics capabilities is a pressing question for scholars as well as practitioners. Fogarty and Bell (2014) note that, while there is extensive literature on IT outsourcing, research on how to effectively outsource data analytics services remains scant. Their exploratory fieldwork suggests that one issue associated with outsourcing analytics is choosing the ‘right’ provider (i.e., one that matches the culture and business requirements of the client). Moreover, Fogarty and Bell (2014) point to issues related to the security measures adopted by the analytics companies. This is particularly true for Generali, as the data acquired and processed by the TSP provider is arguably quite sensitive, especially when we consider that Generali’s black box is equipped with a GPS system that can monitor a driver’s whereabouts at all times.

While Generali currently enjoys the typical advantages of outsourcing arrangements, such as reduced infrastructure investment and strategic flexibility (Lacity, et al., 2009), the firm’s limited control over its TPS provider is an open question. Specifically, the outsourcing of data collection and analytics may limit Generali’s ability to address emergent consumer needs. IT Outsourcing strategies, in general terms, help companies benefitting from competitive and cutting-edge services (Su et al. 2016), yet the outsourcing of data analytics does not seem to apply to well-known best practices. This is especially true if we think of companies’ needs to guarantee consumers’ privacy/security – therefore building trust upon their ability to manage data (and its analytics) properly – while relying on external providers. While a number of encryption-oriented technical solutions have been developed specifically for outsourcing contexts related to data analytics (Liu et al., 2014), consumers’ perceptions of data security and the extent to which the company can choose data protection policies remains paramount (Hartono et al., 2014; Singhal & Padhmanabhan, 2008). Indeed, even if outsourcing service providers can offer superior data security, a consumer may have a negative perception of their driving data not being maintained by the company with which they have signed a contract (Cezar et al., 2013). Therefore, we propose the following research questions:

RQ Set 4:

4a. How do traditional IT outsourcing practices change in the context of big data analytics in the automotive insurance industry?

4b. How does access to, or control of, data impact an insurance provider’s ability to effectively assess and price risk?

4c. What is the role of the consumer's perception in terms of an insurance company's choice around in/out-sourcing policies?

4d. In a broader way, what are the challenges (and opportunities) of data analytics outsourcing?

4.1.5 PAYD Model and Legal/Cultural Systems

Differences in the legal and cultural contexts experienced by organizations sit at the confluence of the strategic and ethical implications of sensor-based PAYD. We contend that many of the strategic choices adopted by the two firms are conditioned by the cultural and legal environments within which they operate (i.e., US and Europe). It is regularly observed that Europe has stricter privacy-oriented laws and regulations than the US (Movius & Krup, 2009). This might lead to differences with respect to the premium that citizens place on issues of privacy (Hallinan et al., 2012). While these general differences have been the subject of significant scholarly inquiry (e.g., Bellman et al., 2004; Harris et al., 2003; Smith, 2001), the IS community could delve deeper into the degree to which such systems condition the strategic use of IT. Moreover, this vein of inquiry suggests areas of interdisciplinary interest, involving fields such as marketing, strategy, IT, law, and sociology, among others. Therefore, it is important to highlight the relevance of pursuing cross-disciplinary research to shed light on these topics. Finally, despite perceptions of heightened focus on privacy matters in Europe, the EU is far for being a cohesive group of countries with similar laws and regulations. Although the EU Parliament centralizes some monetary-policy decisions and the EU Court rules on some major topics (including some privacy ones, such as the Internet-based "right to be forgotten"[5]), EU countries have very fragmented and diverse economies, values, and rights. Therefore:

RQ Set 5:

5a. To what degree do laws and regulations currently affect how consumers relate to PAYD systems in different countries and/or geographical regions?

5b. How do cultural systems related to privacy affect a company's IT adoption strategy around sensor-based technology?

As the preceding discussion suggests, privacy issues are clearly at the center of automotive insurance companies' strategy formulations. In the next section, we consider these issues in greater depth by formulating additional research questions around the degree to which a win-win situation can be established that balances the interests of both businesses and consumers (Newell & Marabelli, 2015).

4.2 OBD and Society: Cui Bono?

In this section we aim to highlight societal questions associated with the adoption of PAYD models. In so doing, we draw and build upon Newell and Marabelli's (2015) framework on the consequences of algorithmic decision-making. The Newell and Marabelli (2015) framework aims at comprehensively addressing broad issues associated with digital devices. Here we narrow our focus to sensor-based technologies and look into the light and dark side of automotive insurance companies' PAYD models. We focus on three main tradeoffs that are privacy vs. security, freedom vs. control, and dependence vs. independence. This tradeoff perspective supports critical reflection on how sensor-based technologies and associated algorithmic 'datification' processes can lead to societal discriminations.

4.2.1 Privacy vs. Security

The most obvious concern associated with the PAYD model is potential violation of personal privacy. Indeed, much of the earlier press coverage of PAYD initiatives emphasized the Orwellian undertones of the innovation (e.g., Fordahl, 2004; Maney, 2004). Researchers assessing the PAYD model have similarly accentuated the privacy threats that it entails (Iqbal & Lim, 2006; Troncoso, et al., 2011). However, as we have noted, sensor-based PAYD can incorporate security-related advantages, such as faster response to impact incidents and enhanced communication between drivers and service providers. For instance, Generali's real-time data capture enables the automated dispatch of emergency services at the moment of an accident – a service that could save lives. Thus, the question is what balance between privacy and security is acceptable from a consumer or societal perspective.

[5] http://ec.europa.eu/justice/data-protection/files/factsheets/factsheet_data_protection_en.pdf

RQ Set 6:

6a. To what degree are consumers willing to forego privacy in favor of enhanced security and service provision in automotive insurance purchasing?

6b. What factors influence consumers' perceptions of privacy in the context of sensor-based systems?

Ownership of the technical elements of a PAYD program raises additional privacy-oriented questions. In the Generali example, the technology and the data collected are owned by a third party TSP provider. Drivers willing to share their data with their insurance providers may still be uncomfortable having that data owned and controlled by a distinct entity. For instance, boyd (2014) suggests that privacy is a combination of people having agency within a particular environment and the ability to understand the environment in a meaningful way to be able to then control how the situation operates. In our context, privacy is associated with individuals' awareness and agency to make decisions on who will collect their data and how the data will be utilized. This implies that privacy, in particular in contexts where IT mediates the relationship between different stakeholders (those who 'give away' data and those who collect it) is a matter of trust (boyd, 2014; Dwyer et al., 2007). Personal data given to a third-party entity decreases one's perceived control over it, whether it is an insurance company or its outsourcer. However, previous research on privacy and trust in the IT domain has mainly focused on end users and their interactions with online platforms (e.g., forums and knowledge management systems; Friedman, Khan & Howe, 2000; Valenzuela et al., 2009). Yet we still need to understand the relationship between privacy and trust in the context of insurance consumption, where consumers gain tangible benefits (discount) by trusting their insurance company. This raises an ethical issue about whether it is appropriate for consumers to be encouraged to give up some of their privacy in exchange for obtaining a better deal with their insurance company. The right to privacy for individuals has a long standing in the study of law (Nizer, 1940; Warren & Brandeis, 1890). Importantly, this right includes "the withholding or concealment of information" (Posner, 1977, p. 393). Naturally, individuals can knowingly provide personal information, but the economic element in the case of automotive insurance implies that 'pressure' to do so may differentially impact individuals based on their socio-economic status. These issues pose a myriad of meaningful interdisciplinary research question, some of which, we argue, could be the following:

RQ Set 7:

7a. To what degree are consumers aware of the parties involved (e.g., who does what) with data collected by sensor-based telematics?

7b. Does the visibility of data provenance impact consumers' perceptions of trust vis-à-vis telematics data collection and use?

7c. What are the moral obligations of insurance companies in terms of retaining and using consumers' sensitive data (in particular those that are GPS-based) that go beyond promising a better annual premium?

7d. To what extent can the IS community use previous research on the relationship between privacy and trust to elaborate on ethical issues in the context of sensor-based technologies?

4.2.2 Freedom vs. Control

A second ethical tradeoff relates to the degree of volition that drivers have. In the current PAYD programs considered, participation is voluntary. Drivers who choose not to participate have their premiums calculated based on traditional underwriting criteria, but they do not lose their insurance and are not otherwise penalized. If early adopters such as Generali and Progressive achieve competitive success based on their PAYD offerings, they may move to make the black box technology a mandatory element for insurance coverage, thereby eliminating an important facet of individual control. More sweepingly, success for the early adopters could engender universal adoption of mandatory participation throughout the automotive insurance industry, with managerial as well as technology-related implications. Therefore, questions such as the ones below should be addressed by the IS community:

RQ Set 8:

8a. What are the ethical issues associated with the widespread diffusion of PAYD systems that draws legitimacy from commercial foundations?

8b. To what degree does voluntary participation influence consumers perceptions of PAYD programs?

8c. In a more general way, what are the implications associated with organizational policies that tie privacy-oriented consumer decisions to offers of economic advantage?

Moreover, it is worth noting that while at the time of this writing enrolling in a PAYD program is voluntary, we know very little about the degree to which drivers are actually aware of the black box technology after they implement it. In other words, even if the initial choice is voluntary – a state of "informed control" (Newell & Marabelli, 2015) – long-term use of such systems could engender a shift towards what can be labeled "semi-informed control". This could potentially create a situation where the initial decision to save money on a car insurance premium leads to constant monitoring, with insured drivers giving away their driving data, or leaving digital traces of the minutiae of their everyday (driving) lives with little awareness (Kehr et al., 2015; Keith et al., 2013). Knorr-Cetina (2001) provides an example where epistemic objects lead to a dissociation between subject and object. When we drive a car we pay attention to the road, traffic, signs, etc., and the car becomes 'invisible' (Werle & Seidl, 2015). PAYD systems can become invisible as well, posing relevant questions regarding the extent to which informed control shifts toward a semi- or un-informed control and the implications of this.

RQ Set 9:

9a. What is the level of awareness of sensor-based tracking among consumers who have used PAYD systems for an extended period of time?

9b. What are the ethical implications of "semi-informed control" that occurs in the long-term, where consumers get used to PAYD systems and can be executed at the expense of an individual's freedom?

9c. To what degree do PAYD systems function as epistemic objects, i.e., taken for granted tools of which one has limited conscious awareness?

4.2.3 Independence vs. Dependence

A final tradeoff that we propose centers on the ethical issues that might emerge from overreliance on PAYD systems. Two important red flags are readily discernible. First, users may receive more or less detailed reports about their driving style, with warnings associated with bad driving behaviors. Therefore a driver will be incentivized to conform to a good standard of driving. However, such standards are largely based on algorithms, which embody statistically-derived conclusions about associations between driving behaviors and outcomes (e.g., braking frequency or rapid acceleration and accidents). However, one could argue that these principles might not be valid, at least in some cases. For instance, it might be better to pass a car quickly (i.e., sharp acceleration) and sometimes exceeding the speed limit could be indicative of safer driving behavior. What if a driver heavily conditioned by the PAYD system prefers to take a risk by passing a car slower than s/he should, just because s/he does not want to negatively affect the monthly driving report for the insurance company? Moreover, it would be interesting to assess whether individuals reflect more or less critically on the inputs provided by algorithms. For instance, it is not uncommon for individuals to follow erroneous GPS directions based on an implicit assumption that "the machine knows" (Saulen, 2009). To this end, being critical in using sensor-based technologies might be relevant – and *safer*, in the context of drivers' behaviors. Thus, we go beyond the direct dependence on automatic systems that literally 'take over' and shift our focus to psychological aspects of dependence – assuming that the insurance company's algorithm reflects an appropriate behavioral norm.

RQ Set 10:

10a. What are the unintended consequences associated with devising individual financial incentives (lower premium) on the basis of statistics made on collectives?

10b. To what extent are individuals 'uncritically' conditioned by sensor-based technologies (and their algorithmically-determined outputs) in their everyday lives?

5 Discussion and Implications

The case that we have made about the emergence of PAYD models raises a wide range of relevant implications that can apply to other industries and contexts. Overall, the diffusion of sensor-based technologies represents a meaningful area of current and future debate within the IS community as it involves relevant practical and ethical concerns for scholars as well as practitioners. At the confluence of these two sides of the PAYD 'coin,' we can discern a couple of overarching themes. First, drawing on our RQ sets 1 and 2, the actions of first-movers such as Generali and Progressive engender speculation about the impacts of more widespread adoption of sensor-based systems, which we refer to as the *societal institutionalization of sensors*. While drivers have to 'opt in' to most existing PAYD initiatives, we anticipate such a voluntary-based model may transition into a mandatory one if the PAYD approach is successful, with the obvious possibility that switching costs would be no longer needed to attract/retain consumers. Second, the PAYD model reflects an interesting dynamic with respect to the management of data and its legal and cultural implications, as per our RQ sets 3-5. In these initiatives, insurance companies are moving from a pricing mechanism based on large-scale statistical analysis (big data) to one that is founded on the minutiae of each consumer's driving behavior, which we label "little data" (Newell & Marabelli, 2015). Wrestling with the implications of a *shift from big to little data* is a pressing challenge as sensor-based initiatives are expanded. Third, as we noted in RQ sets 6-11, the emergence of the PAYD model raises several questions about the degree to which individuals are willing to forego certain measures of privacy, control, and independence in exchange for monetary savings, a phenomenon that we refer to as the *monetization of individual's rights*. Finally, building on the above, we believe that these initiatives provide an interesting arena for juxtaposing the rights of individuals to the rights of organizations to leverage available technologies in pursuit of their core objectives.

5.1 Societal Institutionalization of Sensors

As we have noted, most PAYD initiatives represent options that consumers can pursue voluntarily. Because of the volitional aspect of these offerings, the programs tend to attract more conservative or defensive drivers, who have a reasonable expectation that their safe driving habits will result in a reduced premium. Indeed, this self-selection mechanism is a large part of the value proposition for the insurance providers. The success of such programs will likely influence adoption of similar initiatives by other providers. Furthermore, if the PAYD model results in the *improvement* of driving behaviors for individual drivers (as we have speculated), providers will desire to expand the programs to larger percentages of their policyholders. In this possible future state, the voluntary nature of PAYD insurance would likely be revisited. A mandatory PAYD approach could also result in modification of the 'upside only' structure of such programs (i.e., currently a driver's premiums can only be reduced based on the PAYD data). Shifts of this nature would represent a snowballing effect in the adoption of sensor-based technology within the automotive insurance marketplace. In particular, we argue that one of the main issues could be the extent to which other industries might use the case of the automotive insurance industry to recommend (or, indeed, mandate) the adoption of sensors in much more invasive contexts such as healthcare. In other words, cross-industry snowballing has the potential to institutionalize sensors on the basis of 'statistically' positive outcomes – what ethics researchers call the "teleological approach" (focus on what represents the best solution for most individuals, Berente et al. 2011). This focus on what is good for most individuals, however, is at the expense of minorities who, in the context of PAYD systems, have problematic driving behaviors (e.g., night shift workers who will be penalized for driving in 'dangerous' hours).

5.2 Shift from Big to Little Data

The envisioned shift with the societal institutionalization of sensors also has implications for the management of data. In the predominant risk assessment models employed by insurance providers, premium pricing in based on actuarial analysis of large, historical data sets of diverse risk factors – a big data phenomenon. In contrast to reliance upon trend data, sensor-based telematics allows insurers to concentrate, often in real time, on a specific driver to determine whether s/he is a good or bad driver based on the sensor data from his/her car – an approach that can be described as a "little data" approach. Such a shift, which might have cultural and legal implications, would also have significant ethical ramifications for society with respect to privacy and control.

Interestingly, while much of the ethical exploration of sensor-based telematics that we have developed has focused on the potentially negative consequences of such technology, the shift from big data to little data suggests an ethically positive implication as well. The traditional underwriting process is premised on the concept of essentialism – the idea that all members of a certain classification share certain characteristics that define them (Berente et al., 2011). Essentialist determinations are considered ethically questionable in most western legal system, because they attribute guilt (or innocence) based solely on group classification. The central focus of data analytics is the identification of broad trends within data sets through the application of advanced algorithms. In this way, the algorithms create a mechanism for discrimination (in a benign sense) of factors that contribute to driver risk such as geographic locations that having higher occurrences of speeding or accidents, differences in driving behavior associated with gender. The concern is that this algorithmic approach may be used as a justification for a less-benign form of discrimination based on driver characteristics (Schmeiser et al., 2014). In contrast to reliance upon trend data, sensor-based telematics can now allow us to concentrate on a specific driver to determine whether s/he is a good or bad driver based on the sensor data from his/her car. This can lead to discriminations between individuals that are still based in concrete data (and algorithmic analysis), but are unique to the individuals involved. This could also mitigate the discriminations pointed out in the previous section, where a teleological approach is taken and minorities don't have a say, as big data algorithms 'rule'.

5.3 Monetization of Individual's rights

Another emergent thread highlighted by the adoption of sensor-based technologies in the automotive insurance market is the degree to which consumers may be willing to forego elements of personal privacy, control, and independence in exchange for relatively minor financial benefits. Recent research has highlighted the monetization of privacy, in which individuals relinquish their privacy claim for small advantages in software functionality or personal publicity (Acquisti, 2009; Jentzsch, 2014). This phenomenon has been exacerbated by the widespread use of geospatial social media and location-based mobile applications. Yet the integration of sensor-based technologies into behavioral settings, such as automotive insurance and operation, means that these questions are not limited to concerns for personal privacy; rather, they extend into issues of behavioral control and independence of action. Accordingly, we argue that this phenomenon may be more broadly characterized as the *monetization of individual rights*. As sensors become more deeply embedded into our lives and behavioral patterns, we must explore the calculus that individuals apply in exchanging their personal rights for monetary gain. Furthermore, the question of whether socio-economically disadvantaged individuals are more pressured to relinquish their individual rights is a critical point for exploration, and here we recommend that the IS community takes this issue in serious account.

5.4 Balancing the Rights of Individuals and Organizations

Sensor-based technologies provide a clear benefit to insurance providers. From an underwriting perspective, the behavioral visibility created by the black box systems represents a dramatic enhancement of insurer's ability to match premiums to the underlying risks incurred. Thus, the adoption of such technology is intuitively appealing and ethically justifiable given the inherent nature of insurance. Indeed, from a business perspective, insurers would likely ask why policyholders would want their premiums to be based on anything other than *their own* behavior. However, as we have discussed, the implications of this adoption are far from trivial in terms of the privacy, control, and the (in)dependence of individuals (i.e., in relation to our RQ sets 6-11). This contradiction reflects a classic example of an ethical dilemma – i.e., states in which multiple choices are available but all options entail the compromise of some ethical principle (Culnan & Williams, 2009; Martinsons & Ma, 2009). In this case, the stance that insurance providers have a right (and indeed a fiduciary responsibility) to gather data that enables them to more accurately price the risks associated with individual policyholders conflicts with the position that individuals have a right to privacy and control over their own behavior. Exploration of this ethical dilemma will be a valuable research effort as sensor-based systems become more deeply embedded in contemporary life.

5.5 A Broader Outlook on Sensors in Business and Society

Insights gleaned from the automotive insurance context suggest multiple avenues along which to examine the business and ethical impacts of these emerging and extremely pervasive technologies in a wider array of settings. As we previously noted, production processes and facilities, healthcare and other service industries, and scientific research on earth and space (esp., climate change and weather prediction for disaster management) are, among others, being dramatically impacted by the adoption of sensors and their integration with centralized databases. Indeed, these changes are at the heart of the Internet of

Things (IoT) phenomenon, with cloud-based aggregation and sharing of data collected by a distributed network of sensor and actuator devices (Gubbi et al., 2013).

For some industries, a major (and somewhat disruptive) change associated with the introduction of sensors relates to the necessary transition from a static and exclusively human-based production control to a more dynamic and IT-based type of control (cf. Westergren & Holmström 2012). Plants, machinery, and production processes in general are no longer fully managed by human beings; rather, sensors support (or at times direct) individuals who are involved in these activities. As with our study of the automotive insurance industry, production processes are subject to a variety of ethical concerns. For instance, people being controlled by sensors will feel less empowered, with the potential for detrimental impacts on individual performance, the ability to make positive links between personal achievement and organization success (i.e., engagement), and ultimately the ability to produce and share innovation organization-wide (Hasan & Subhani, 2011). Ethical implications also arise from the performance-related assessment of employees. One example is Hitachi's new digital identification badge that collects data on an individual employee's exact location within an office, records who the person has spoken to, for how long, and how energetically[6]. Thus, ethical dilemmas are brought to the surface by the contrasting needs of companies (e.g., performance, productivity) and individuals (e.g., privacy, autonomy).

Other industries face the potential of even more radical changes related to sensors. In recent years, several healthcare services have adopted a variety of sensor-based innovations, such as the use of wearable devices. While product/service innovations such as fit-bit (https://www.fitbit.com) represent valuable assets for consumers, who can constantly monitor their 'well-being', the vital statistics captured by these devices are also sent to a centralized database, because this allows users to access health information from everywhere (phone, computers, tablets). However, this might pose ethical issues for at least two key reasons: First, we know very little about the IT security measures adopted by the companies that store our medical data. Second, we don't know for how long these data will be stored and if/when in the future they will be available, and to whom. For instance, clinical research will benefit from such a vast database of individuals' vitals, especially if associated with future medical conditions of the data owners. Yet, medical progress may conflict with individual's privacy, especially if health data is shared with third-party organizations. For instance, in the U.S. healthcare system Health Maintenance Organizations (HMOs) might refuse to insure patients whose wearable device data reports show 'red flags' of potential pre-conditions associated with arrhythmia, tachycardia, high blood pressure, or frequent fever. In sum, sensor-based applications in the automotive insurance industry and the consequent changes in its business model might represent a good start to understand the broader effect that such technologies will have on individuals, businesses, and society at large.

6 Conclusion

In this position paper, we have showcased how relatively mature technologies (sensors and OBD) can be leveraged to introduce innovative business models. In the automotive insurance context, these technologies are engendering massive, prediction-enabling data collection, with the potential to dramatically enhance the effectiveness of certain business processes (e.g., risk assessment, underwriting). At the same time, these technologies create the ability to monitor individuals, with significant implications for their privacy, behavior control, and independence. Accordingly, we contend that the IS community must pursue a wide range of questions regarding the advantages and disadvantages of such algorithmic mechanisms of consumer discrimination at individual, organizational, and societal levels. A superficial consideration of the PAYD business model suggests a win-win scenario – insurance companies augment their profits through enhanced risk assessment, while good drivers pay less. However, a more thoroughgoing analysis reveals the potential for conflicting outcomes and unintended consequences of the adoption of these innovations (e.g., the threat of discrimination and loss of privacy). Ironically, while consumers currently have a choice in the use of sensor-enabled PAYD, the success of the model may increasingly leave the choice in the hands of the insurance companies, with penalties for consumers who do not comply. The automotive insurance marketplace provides a prominent context for the exploration of these issues, but we believe that the questions are far more wide-reaching and similar questions apply to a variety of other industries impacted by sensor adoption. Ultimately, the issues raised here have implications for such diverse phenomena as big data analytics, machine learning and

[6] http://www.cnn.com/2014/02/02/opinion/greene-corporate-surveillance/

algorithmic decision-making, social media environments, information security, and information-oriented public policy. All of these threads represent rich domains for novel IS research.

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