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ASSESSING THE EFFECTS OF BENEFITS AND INSTITUTIONAL INFLUENCES ON THE CONTINUED USE OF ENVIRONMENTALLY MUNIFICENT BYPASS SYSTEMS IN LONG-HAUL TRUCKING[1]

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Commercial truck driving is an essential part of the national supply chain but one that adversely affects the environment. The purpose of this study is to determine the influence of the potential environmental benefits, among other factors, on continued use of bypass systems that can be discontinued at any time by a driver. The results from our study show that (1) economic benefits and industry pressures positively influence drivers' use of bypass systems but (2) the environmental benefits of the technology do not, even though system vendors and state transportation agencies emphasize these benefits of the technology. Based on these findings, we conclude that sustainable information systems can be a viable option in a business context if usage leads to economic benefits. Our results and conclusions support the U.S. Environmental Protection Agency's differentiation of public policy versus business perspectives on sustainable technology.

Keywords: Sustainable information systems, energy informatics, commercial trucking, intelligent transportation systems

Introduction

It is difficult to overstate the value of the motor carrier industry to the world economy. In the United States alone, there are 3 million large trucks and 5.3 million commercial trailers piloted by 3.5 million truck drivers. Moreover, one of every 13 people working in the U.S. private sector is employed in a trucking-related job, and roughly 80 percent of U.S. communities depend entirely on trucks to deliver their goods (Global Insight 2005). Indeed, there is much truth to the industry adage that "if you got it, then a truck brought it." While critical to the global economy, this industry is also responsible for a significant and growing level of environmental degradation. According to the U.S. Federal Highway Administration (FHA), medium- and heavy-duty truck emissions rose by more than 70 percent between 1990 and 2008, the largest percentage increase of any major transportation mode. Initiatives to combat these environmental hazards have fostered practices and helped develop systems that have improved sustainability in the transportation industry. For example, the FHA reports that the mandated use

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of fuel-efficient, ultra-low sulfur diesel engines helped reduce total truck emissions from 425.2 million metric tons of CO_2 in 2007 to 401.2 million metric tons in 2008. However, the Environmental Protection Agency estimated that it cost trucking firms $4,300 per vehicle to retrofit existing engines to meet the 2007 emission standards. This is an onerous expense for most carriers, given the extremely competitive nature of the motor carrier industry and the thin profit margins of its members.

Expanded use of *intelligent transportation systems* (ITS), a category of sustainable information systems, may be a more viable way to protect both the physical environment and the economic health of this industry. Commercial delivery companies (e.g., FedEx, UPS) currently use ITS to determine delivery schedules and routes in urban areas. Another type of ITS, which is the focus of this study, is a bypass system that allows truck drivers to bypass toll booths and highway weigh stations, reducing idle time and overall mileage. These efficiencies, in turn, translate into reduced greenhouse gas emissions—an important goal of the United States federal government (U.S. Department of Commerce 1999).

Like other sustainable information systems described in the energy informatics framework (Watson et al. 2010), bypass systems are composed of flow networks, sensor networks, and sensitized objects linking environmental goals with the actions of resource consumers. A *flow network* incorporates the connections that allow the flow of material from endpoint to endpoint, which in this context is comprised of the highway system itself. By verifying transport information about commercial vehicles utilizing public highways, bypass systems optimize the flow network by reducing potential bottlenecks at checkpoints within the network (e.g., weigh stations). *Sensor networks* include devices that remotely relay information about a physical item. Transponders within the vehicle and receivers located at proximate highway weigh stations serve as the sensor devices in the bypass system. Finally, *sensitized objects* are physical items that have the capability to report data for future management and analysis. Trucks equipped with transponders fit this description because they transmit information about the truck's weight and cargo, as well as the driver's hours of service, to receivers located at highway weigh stations along the vehicle's route. Normally, drivers must leave the highway (generally an interstate) and stop at weigh stations where their trucks are examined to ensure compliance with weight and length restrictions and the driver's log is inspected to ensure operation within federal hours of service rules. Bypass systems enable truck drivers to avoid these delays, which can last up to an hour at some locations. Figure A1 in Appendix A displays a typical bypass procedure.

Despite their wide ranging benefits to the carrier, the driver, and the environment, bypass systems have not been universally adopted by trucking companies or independent owner operators. The lack of widespread adoption is puzzling from at least two perspectives. From a macro business perspective, the failure to adopt bypass systems suggests that drivers and companies are making a conscious decision to place themselves at a competitive disadvantage to those who use the system. From an information systems perspective, questions arise as to the role of drivers as end users of the system. Because individual drivers can choose to discontinue using these systems at any time, their role as end user is central to the effectiveness of these complex multistakeholder systems. To our knowledge, there has been no research into the decision-making of the actual end users of intelligent transportation systems.

Accordingly, the current study seeks to answer the question: How important are personal benefits and institutional pressures for current end users when deciding to continue using sustainable information systems? Personal benefits are evaluations of rewards that encourage an individual to engage in an activity, and institutional pressures reflect the influence of external institutions on the decision to engage in the activity. These factors were selected because they have been found to promote the adoption and diffusion of interorganizational systems (Robey et al. 2008) like bypass systems. Thus, the purpose of this research note is two-fold. First, we hope to further our understanding of the influence of these antecedents on truck drivers' intentions to continue using bypass systems. Second, our findings can help government agencies, industry groups, and nongovernmental organizations design promotional campaigns and/or incentive programs that more effectively encourage the continued use of bypass systems and other sustainable information systems.

Conceptual Background and Hypotheses

Personal Benefits

Environmental

Environmental benefits are defined as *improvements to the environment and to an individual's well-being gained from the individual engaging in sustainable business practices, systems, and technologies*. Research has shown that the adoption of sustainable practices at the individual level is intrinsically motivated (DeYoung 2000; Seidel et al. 2010). According to self-determination theory (Ryan and Deci 2000), intrinsic rewards arise when individuals engage in activities that not only are perceived to be enjoyable, but also boost personal self-esteem and pride, aid in reaching another related goal, or help avoid feelings of guilt from not performing the activity. Although intrinsic rewards can encourage information system usage (Agarwal and Karahanna 2000; Venkatesh 2000), it remains to be seen if the rewards gained from reducing one's environmental impact (DeYoung 2000) exert a similar influence.

Truck drivers may be motivated to adopt bypass systems because of personal desires to help the environment, to improve societal conditions, and/or to take pride in an industry that meets its civic responsibilities. Despite their limited use, bypass systems have had a positive impact on the environment. The 400,000 vehicles enrolled in PrePass, one of the leading bypass systems, have reduced fuel usage by more than 150 million gallons and emissions by 335,000 metric tons (Hansen 2010). Extrapolating these numbers to all 11 million medium- and heavy-weight vehicles suggests bypass system use would save 4.1 billion gallons of fuel over a decade. These systems provide other environmental benefits such as decreased road congestion and engine idle time (Crainic, Gendreau, and Potvin 2009). Indeed, state transportation agencies and bypass system providers emphasize the safety and environmental benefits of these systems and advise drivers to take pride in their membership (Gelinas 2009; IDOT 2011; MTA 2010). It is, therefore, reasonable to assume such messages would influence truck drivers' attitudes toward the system, especially if they boost drivers' self-image and/or mitigate feelings of guilt.

H1: Higher perceived societal environmental benefits are positively associated with intentions of continued usage of bypass systems.

Financial Rewards

While some leaders are intrinsically motivated to introduce sustainable information systems to their organizations (Seidel et al. 2010), they may not be persuaded solely by environmental benefits. Another likely motivation is financial rewards derived from *the monetary incentives directly gained from the use of a business practice, system, or technology* (Chwelos et al. 2001). Financial rewards are extrinsic in nature and are gained "whenever an activity is done in order to attain some separable outcome" (Ryan et al. 2000, p. 71). Financial rewards are one of the most effective ways to motivate individuals to engage in environmentally friendly practices (Govindarajulu and Daily 2004; Lent and Wells 1994).

Users of bypass systems accrue financial benefits in several ways. For instance, not only is the number of current users large enough to maintain the integrity of the network, users benefit from a system whose costs were incurred by others (Gallaugher and Wang 2002; Katz and Shapiro 1985). There are also more direct financial benefits associated with the adoption and continued use of a bypass system. An early study found that trucks using a bypass system saved 0.17 gallons of diesel per bypass, and possibly more when in stop-and-go queuing conditions averaging four miles per hour (McCall et al. 1998). A 2007 economic analysis conducted by the Motor Carrier Industry Association estimated that a driver's operating cost savings are $8.68 per bypass. Since drivers can bypass up to six weigh stations per day, these savings quickly outweigh the $16.80 monthly subscription fee. Bypassing toll booths and weigh stations also reduces the negative financial impacts of stop-and-go driving on truck, engine, and driveline maintenance (Brown et al. 2007; Golob and Regan 2001). Insurance rates might also be reduced due to the automated capability to detect improperly balanced vehicles (Orban et al. 2002). Finally, earlier research suggests that members of interorganizational networks reap cost savings due to accurate, timely information exchanges among partners, and to electronically processing documents that were formerly handled manually (Mukhopadhyay et al. 1995).

H2: Higher perceived personal financial benefits are positively associated with intentions of continued usage of bypass systems.

Accessibility

Accessibility is defined as *a measure of one's ability to participate in product-related activities within his or her environment* (Miller 1999). From the driver's perspective, accessibility is largely dependent on the number of locations served by the bypass system. As of October 2011, PrePass could be found in 30 U.S. states and available at 292 of the 1,192 weigh stations nationwide. Accessibility also exists beyond weigh stations, as some private sector firms use bypass systems to offer automated gate access to freight yards and terminals.

The bypass system network is likely to continue growing and increase in accessibility. A significant reason for this expectation is the fact that bypass system companies provide their systems to state transportation agencies at no cost. By offering their systems free of charge, these companies increase the number of member weigh stations and toll booths. This enhanced accessibility makes such systems more attractive to drivers because they offer more opportunities to accrue time and cost savings than do smaller bypass systems (Katz and Shapiro 1986). In turn, each additional truck driver adopting the bypass system not only pays a monthly subscription fee, thereby increasing the revenues of the bypass system company, but also makes the system more attractive to other states because of its increased potential to reduce congestion and pollution (Nault and Dexter 1994). Because perceived benefits increase as accessibility increases, it is likely that

H3: Higher perceived system accessibility is positively associated with greater intentions of continued usage of bypass systems.

Institutional Pressures

Truck drivers' intentions to use bypass systems may also be shaped by institutional pressures. According to institutional theory, decision makers operating in the same environment tend to demonstrate regularized or homogeneous behaviors consistent with those of similar others (DiMaggio and Powell 1983; Scott 1995). Firms that do not conform to the institutional pressures in their environment risk incurring higher transaction costs, which can put them at a significant competitive disadvantage. The motor carrier industry is heavily regulated and highly competitive (especially in terms of price), with low barriers to entry and considerable overcapacity. Carriers and owner operators are constantly searching for ways to cut costs and to differentiate themselves from competitors. Drivers who use bypass systems may see their usage as a source of competitive advantage, and therefore will continue its usage as long as the benefits outweigh the expense (i.e., the monthly subscription fee).

There are three categories of institutional pressures: mimetic isomorphism, coercive isomorphism, and normative isomorphism (DiMaggio and Powell 1983). Mimetic isomorphism occurs when decision makers feel pressured to mimic the practices of competitors within their industry. In this study, mimetic isomorphism was operationalized using perceived competitive pressure and perceived competitive participation. Perceived competitive pressure refers to *the pressure experienced by an individual to maintain or increase one's competitiveness within an industry* (Chwelos et al. 2001). Perceived competitive pressure is expected to have a significant influence on the continued use of sustainable information systems in the highly competitive transport industry. Trucking companies and independent contractors increasingly seek innovative processes to enhance their competitiveness (e.g., Giordano 2008; Han et al. 2008). The decision to continue usage of bypass systems can be expected to be motivated by users' desire to maintain or improve their competitive standing within an industry.

H4: Higher perceived competitive pressure is positively associated with intentions of continued usage of bypass systems.

Perceived competitive participation, our second operationalization of mimetic isomorphism, is defined as *the prevalence of a business practice, system, or technology in a competitive industry* (Teo et al. 2003). From a bandwagoning perspective, there is a direct relationship between the perceived number of users of a system and the adoption of that system (Liang et al. 2007). When numerous competitors and peers have adopted a system, non-adopters come to fear they will be perceived as less innovative or less adaptable to external conditions (Teo et al. 2003). To avoid embarrassment, these non-adopters become adopters. This "herd behavior" can be so influential that it supersedes decision makers' own rationales (Duan et al. 2009). Drivers see the advantages of bypass systems through visual observations of other drivers bypassing weigh stations, and likely hear about system advantages during casual conversations with other drivers. We expect that these observations will pressure truck drivers to continue using bypass systems.

H5: Higher perceived participation in the bypass system by competitors is positively associated with intentions of continued usage of bypass systems.

The second institutional pressure, coercive isomorphism, involves pressures exerted by organizations on which the decision maker either depends (e.g., governmental agencies; more powerful business partners) or competes with, as well as pressure to meet societal expectations (DiMaggio and Powell 1983). Because there is no legislation mandating the use of bypass systems, any coercive pressure on drivers to use these systems likely comes from the carriers who employ or contract with them. Thus, coercive isomorphism is represented in this study by organizational pressure, which is defined as *the pressure exerted by an organization on individuals dependent on it to adopt and use practices, systems, and/or technologies that serve its interests* (Teo et al. 2003). An ITS aids the carrier in its normal business operations by helping dispatchers plan the shortest, most efficient routes for their drivers, thus helping them meet delivery schedules (Crainic, Gendreau, and Potvin 2009). Because bypass systems allow drivers to bypass toll booths and weigh stations, more freight can be delivered to customers in less time and therefore driver productivity is increased. But these benefits can be achieved only if drivers comply with the company's wishes that they use the system. It is for these reasons we expect that organizational pressure will encourage further usage of bypass systems.

H6: Higher perceived organizational support for the use of bypass systems is positively associated with intentions of continued usage of bypass systems.

A third institutional pressure, normative isomorphism, also involves decision makers copying the practices of others, but at a more subconscious level due to shared mental models developed through similar experiences, training, or direct peer interaction (Bala and Venkatesh 2007; Shi et al. 2008). To remain competitive, individuals may be receptive to advice and suggestions offered by industry experts. We use the term *industry pressure* to refer to *the efforts exerted by industry groups to encourage a potential customer to adopt and to encourage existing customers to continue using a particular product* (Chwelos et al. 2001; Hirt and Swanson 2001).

Industry pressure is often manifested in advertisements appearing in trade publications and related outlets. These efforts try to increase potential users' awareness of the benefits of a system (Iacovou et al. 1995), and thus encourage its use (Tung and Reick 2005). One example occurred when a concerted "push" was made to help truck drivers understand the convenience and financial benefits of using gas-accounting information technologies (Nault and Dexter 1995). We expect pressure from industry groups to be similarly effective for promoting bypass systems use.

H7: Higher perceived industry pressure is positively associated with intentions of continued usage of bypass systems.

Based on the previous theory review, we developed and tested a research model accounting for the influence of personal benefits and institutional pressures on truck drivers' intentions to continue using bypass systems. Given the magnitude and distant horizons of sustainability's economic impact on affected organizations, studies in this area must take a long-term orientation. Accordingly, we positioned our dependent variable, *intentions to continue use*, using a long-term perspective. Appendix B describes the items selected for intention to continue use in detail.

Methodology

Procedure

Previous research on ITS has typically operationalized "system users" as terminal, logistics, or operations managers (e.g., Golob and Regan 2002; Hall and Intihar 1997). However, we operationalized system users as truck drivers with active bypass system accounts because their ability to turn off the truck's transponder gives them ultimate control of system use.

A paper-and-pencil survey was used to collect data from active company drivers and owner operators. Each of the current researchers solicited responses. Approximately 680 randomly selected drivers at 7 truck stops in 4 different states in the southeastern United States were given surveys. Surveys were either completed on site or returned by mail, producing a final sample of 212 usable survey responses. Appendix C provides the demographic characteristics of the final sample used for data analysis. By personally administering the survey, the researchers often received first-hand qualitative feedback about bypass systems from the truckers themselves. Notable comments are included in the "Discussion" section.

Measures

Table 1 lists the individual items associated with each construct used in this study. Three formative benefit factors and four reflective factors representing institutional pressures were measured. The dependent variable—intentions to continue usage—was measured using two items crafted for the specific context of bypass systems. We used SmartPLS (Ringle et al. 2005) to test the research model. PLS is considered to be most appropriate when a research effort is in its early stages, or when more emphasis is placed on identifying possible relationships between the constructs than on the magnitude of those relationships (Goodhue et al. 2012; Götz et al. 2010). The internal composite reliability for the reflective constructs all exceed the recommended 0.7 level (Fornell and Larcker 1981). Variance inflation factor scores (VIF) for the formative measures are below the threshold value of 3.3 (Diamantopolous and Siguaw 2006), indicating that multicollinearity is not a threat.

Because data were collected from a single source (i.e., an individual driver) at a single point in time, we accounted for common method bias and threats to internal validity. These and other details about the measurement model (e.g., factor and item weight loadings) are provided in Appendix B. Common method bias did not appear to unduly sway the results of the analysis.

Analysis and Results

We tested our hypotheses with PLS bootstrapping using 500 samples and individual sign changes to estimate the significance of the path coefficients (Chin 1998). PLS does not pro-

Table 1. Construct Measures

Construct	Items
Environmental Benefits	Paper reduction
	Reduced traffic congestion
	Reduced truck emissions
Financial Benefits	Reduced fuel costs
	Reduced insurance rates
	Reduced paperwork costs
	Time savings
Accessibility	Large number of weigh stations offering bypass capability
	Automated gate access to terminals
Competitive Pressure	I feel a lot of pressure to use bypass systems because drivers from other companies use them.
	Bypass systems help me remain competitive.
Participation Among Other Drivers	Percentage of your company's drivers that use bypass systems
	Percentage of all drivers that use bypass systems
Organizational Pressure	I use bypass systems because my company wants me to.
Industry Pressure	Number of times a year receiving promotional material from bypass system developers
	Number of times a year receiving promotional material about bypass systems from professional organizations or trade newsletters
Intention to Continue Use	I would not drive for a company that does not use bypass systems.
	I will not subscribe to bypass systems unless the company reimburses me.

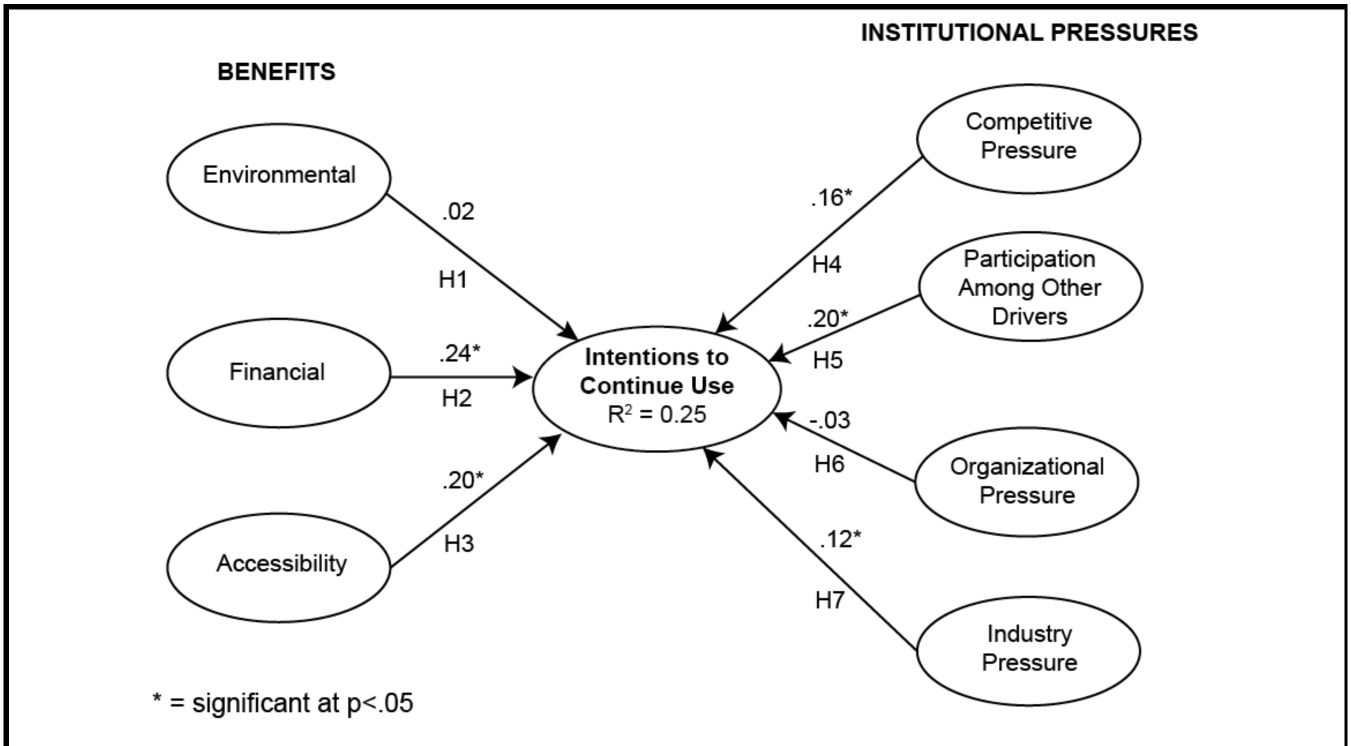

Figure 1. Results of Testing the Research Model

vide goodness-of-fit indices, so the predictive power of the structural model was assessed by the amount of variance explained in the dependent latent variables. Results of the structural model (Figure 1) indicate that 25.2 percent of variance of the intention to continue usage measure was explained.

Five of the seven hypothesized relationships were statistically significant at the $p < .05$ level. Hypothesis 2, which predicted financial benefits would positively influence intention to continue using the bypass system, was supported, as was Hypothesis 3, which predicted a similar influence from accessibility. Hypotheses 4, 5, and 7 were also supported. They predicted positive effects from mimetic pressure—operationalized as competitive pressure and participation among other drivers—and industry pressure, respectively. Conversely, neither Hypothesis 6, which pertained to the influence of organizational pressure, nor Hypothesis 1, which predicted a positive influence from environmental benefits provided by the system, was supported.

Discussion

Major Findings

A major objective of our study was to determine whether personal benefits and institutional pressures influence intentions to continue using a system that was developed, in large part, to reduce environmental consequences of normal business operations. This is a critical issue not only for the trucking industry, but also for other industries adversely affecting the environment.

Benefits

Our findings demonstrate that financial benefits are an important consideration in truckers deciding to continue using bypass systems. There are several explanations for this result. First, long-haul trucking is not a particularly well-paying occupation. The Bureau of Labor Statistics reports that the mean annual wage for this job was $39,260 in 2009; the mean annual wage for all U.S. occupations that year was $43,360. This disparity suggests that many drivers may find it difficult to meet the financial needs of themselves and their families. Under these conditions, the financial benefits of adopting sustainable information systems will have more influence than a grander but more distant desire such as protecting the environment. Second, few drivers are paid a set wage. Almost all drivers are compensated based solely on the number of loaded miles driven. Thus, the less time drivers spend at weigh stations and toll booths, the more time they have for driving, subsequently increasing their pay.

Our quantitative findings are largely consistent with the verbal comments truckers made to the researchers. Many comments clearly show that truckers appreciate the financial and operational benefits of bypass systems. Several drivers mentioned fuel savings (e.g., "Every time I have to stop at a weigh station, it costs me 75 cents") while others claimed that each bypass saves up to 15 minutes. These estimates are consistent with industry studies. Many drivers also pointed out that they could make up to six bypasses a day, which would sharply multiply these savings over time. Interestingly, other comments indicate that some drivers themselves have become champions of bypass system use. For example, several drivers asked us to meet with their managers to support their requests to adopt bypass systems.

Our results also show that accessibility benefits influence continued use of these systems. This is understandable given that increased accessibility means drivers will make fewer stops, thus increasing the likelihood of gaining bypass systems' financial benefits. Somewhat surprisingly, our findings indicate that drivers are not influenced by environmental benefits. However, we feel that any conclusions that drivers are unmotivated by or unconcerned about environmental benefits are premature. We base this cautious interpretation on a potential interaction between truck drivers' economic difficulties and bypass systems' financial benefits. In other words, the combination of these two factors may simply overshadow drivers' assessments of the environmental benefits of bypass systems.

Institutional Pressures

Mimetic and normative pressures were found to be significant predictors of continued use intentions. The importance of these pressures is understandable given that long-haul trucking is a highly competitive industry whose members provide very homogeneous (almost commodity-like) service to an extremely price sensitive customer base. Hence, because carriers compete largely on the basis of price and on-time delivery, they place great emphasis on reducing operational costs and travel time. Bypass systems enable carriers to achieve reductions in both. Again, a carrier whose cost and delivery time structures are only marginally higher than those of the competition could be at a significant disadvantage in this highly competitive industry. In keeping with institutional theory, when one company is able to reduce its cost structure while improving service quality, there is unrelenting pressure for competitors to do the same. Consequently, and somewhat paradoxically, these types of industries may offer the greatest potential for widespread adoption and continued usage of sustainable information systems *if* they also offer sufficient financial benefits. Similarly, the finding that normative industry pressure is a strong motivator of intentions to continue using bypass systems is consistent with previous research (Khalifa and Davison 2006; Teo et al. 2003). However, our study also demonstrates that institutional pressures influence operation-level employees, not just top managers. To our knowledge, this point has been seldom explored in previous research.

The nonsignificant relationship between coercive/organizational pressure and intentions to continue use is somewhat puzzling. We suggest two possible reasons for this finding. First, organizational pressure is believed to be most effective when the subordinate member in the coercive relationship (e.g., the individual truck driver) is heavily dependent on the superior (e.g., the carrier) (Kostova and Roth 2002). However, the inordinate amount of voluntary driver turnover in the industry suggests drivers are less likely to be swayed by organizational mandates. Second, drivers who recognize the benefits of bypass systems may try to exert pressure—albeit limited—on reluctant managers to subscribe to these systems. While collecting data, we heard many drivers complain that their companies were "too cheap" to adopt bypass systems even when the drivers felt they were needed. This context is quite different from that found in most technology acceptance research studies, which attempt to explain why "end-users are often unwilling to use available computer systems that, if used, would generate significant performance gains" (Davis et al. 1989, p. 982). Perhaps our results approach a boundary condition of technology acceptance models (i.e., where the user strongly wants the system and will employ it regardless of organizational support).

Limitations

The first limitation pertains to the generalizability of these findings. Although we believe our conclusions can be extrapolated to other business domains, we have interpreted them within the context of one specific industry and with one specific information system during a period of considerable economic difficulty. Second, we could not control for the numerous types of freight shipments (e.g., time-sensitive cargo which may benefit more from the time-saving aspects of bypass systems). Likewise, owner-operators have a contractual relationship with their carrier, whereas company drivers have a traditional employment relationship.

Third, the emission of greenhouse gases by the transport sector is an international issue. Globally, this problem is being addressed in a variety of different ways. For example, China is emphasizing fuel-efficient truck technologies. The European Union is focused on integrating communication networks, traffic control centers, incident detection systems, monitoring systems, and car navigation systems. In both of these approaches, the end user has much less influence on system usage than the drivers have in this study, and coercive pressure from the government would likely be much different than the organizational pressure represented in this study. Hence, the extent to which our findings can be generalized to international settings must be questioned.

Implications for Management

Trucking Industry Managers

Perhaps the most immediate managerial implication from our study concerns drivers who want to use a sustainable information system that some management teams are slow to implement. Failure to respond to driver demand for bypass systems poses at least two risks for management. First, they provide drivers with yet another reason to change carriers (i.e., go to work for a "less cheap" company). Second, drivers who support bypass systems understand their financial benefits, suggesting that these drivers are perhaps more knowledgeable—and thus more valuable—than other drivers. Given the severe, longstanding problem of voluntary turnover in the transportation industry, few carriers can afford to help high-value drivers decide to leave.

A second implication involves the way bypass systems allocate costs and benefits across firms. Drivers reported that the bypass systems' current "pass/no pass" decisions (see Appendix A) are based on the company's—*not each driver's*—aggregate driving record. These drivers also deduced that a company with poor aggregate driver records can create a vicious domino effect for self-described "good drivers in bad companies." That is, the company's poor record penalizes good drivers because they do not receive their fair share of "pass" decisions. Consequently, these drivers do not accrue the resulting time and operational benefits—or the resulting increase in wages—they feel they deserve. This unexpected combination of personal benefits, network effects, and institutional pressures suggests that managers who want to promote sustainable information systems should understand that the factors that affect the organization's upper levels also influence their subordinates in similar ways. Hence, both groups are likely to respond equally well to similar appeals stressing financial and operational benefits.

Government Agency Managers

The current study also speaks to the role system users and managers can play in the transition from a government-funded initiative to a sustainable information system supported by a private enterprise. Firms must establish a new operational equilibrium in favor of new business initiatives in order for them to survive after subsidies have ended (Elliot 2011; Minniti and Bygrave 2001). Should the new initiative fail to be supported by the users affected by it, especially in the case of sustainable initiatives, firms have a tendency to return to old systems and practices (Berrone et al. 2010). Our findings suggest that, in the case of bypass systems and the trucking industry, a successful transition is more likely if a bottom-up demand from end users exists, even though the demand is not based on potential environmental benefits. Other ITS efforts aimed at improving congestion in urban areas, such as city logistics systems that are initiated by governmental agencies (Benjelloun et al. 2010; Crainic, Ricciardi, and Storchi 2009), may gain more traction by promoting the benefits for end users and stimulating bottom-up demand for the systems.

Thus, we suggest that targeting truckers with messages promoting financial and accessibility benefits will be more effective than focusing on environmental benefits alone. Similarly, state transportation agencies can use accessibility benefits when targeting their legislators and non-trucking constituents about the need to expand bypass systems. These arguments are consistent with other research showing that decision makers tend to adopt sustainable information systems and technologies that are both economically sound and socially desirable (Jaffe et al. 2005). This would seem equally applicable to private sector companies, public agencies, and individuals with limited discretionary incomes. In short, the most effective strategy for marketing sustainable information systems appears to be developing different strategies that are relevant and meaningful to particular target audiences.

Implications for Research

Our findings and management implications suggest several avenues for future research. First, our study highlights the influence of normative and mimetic pressures on intentions to continue using bypass systems. Future research can assess the role of these factors in the continued use of sustainable information systems, or even of general IS. While past research suggests that personal benefits and external pressures will continue to be meaningful once the system is adopted, our findings suggest that factors affecting managerial decisions (e.g., network effects and competitive advantage) may also influence end users. Future research in this area should assess the extent to which users see the relevancy of sustainable information systems in terms of how they help them and keep their company competitive.

The issue of how the multidimensional complexity of green information systems influences the decision to adopt and to use also requires further study. For example, do managers target different stakeholders with different messages (e.g., environmental messages for the public; financial benefits for end users), and if so, then how are these different strategies associated with continued ITS use? To our knowledge, this has not been widely addressed. Moderators shown to be important in other environmental efforts (e.g., the amount of perceived effort required to adopt a new sustainable process; Dahab et al. 1995) should also be explored.

One particularly interesting question stems from driver complaints about managers who are too cheap to implement bypass systems. The financial benefits provided by the systems suggest, however, that their managers' misgivings are rooted elsewhere. Negotiation and conflict resolution research (e.g., Maoz et al. 2002; Neale and Bazerman 1991) suggests that this attitude may result from decision makers' reactions to the source of the information rather than to the information itself. When decision makers devalue information solely because of its source, they may be more likely to make poorly informed, suboptimal decisions. Nolon (2011) has speculated that this phenomenon—called *reactive devaluation*—may have spurred past opposition to sustainable efforts such as wind turbine farms. There are at least three information sources that might be devalued by trucking managers. The first is the drivers themselves, as managers may believe these individuals lack sufficient sophistication to adequately evaluate complex ITS like bypass systems. The second and third sources are government agencies and environmental groups, respectively, that promote sustainable efforts, as managers may perceive them as being adversaries of the trucking industry. When trucking managers devalue information about the economic benefits of bypass systems simply because of their attitudes toward the source, they may be more likely to choose non-adoption (i.e., the financially suboptimal alternative). Future research examining cognitive biases such as reactive devaluation could provide an interesting perspective to adoption and acceptance research (Davern et al. 2012).

Additional research is also needed to elucidate how not-for-profit managers address the adoption of green information systems. When compared to drivers and for-profit managers, not-for-profit managers would be expected to weight sustainability benefits more and financial and operational benefits less. These expectations, along with differences in the ways not-for-profit managers judge the relative importance of reallocated externalities (e.g., traffic congestion, air pollution, and other environmental costs; Quinet 1997) and the methods of reallocation (e.g., Pigouvian taxes versus non-regulatory ways; Coase 1960) remain to be studied. In the trucking industry, for example, there are industry-specific characteristics that likely limit the effectiveness of Pigouvian measures in lessening environmental impacts. Publically funded systems and technologies that deliver time and monetary savings, in addition to environmental benefits, may be a more effective way to protect the environment. Thus, there is a need to research alternatives to these taxes (Watson et al. 2010). Research should also investigate whether systems that enable the user to gain financially from "doing the right thing" are more effective than taxes that penalize them for "doing the wrong thing."

Conclusion

By focusing on a system that was developed in part to reduce the environmental impact of an essential part of the national supply chain, our results provide important insights into the role of information systems in promoting sustainable business practices. In particular, our findings show that the financial, accessibility, and competitive benefits of bypass systems are of considerable importance to ultimate end users and should be emphasized accordingly. Our findings do not suggest, however, that sustainability benefits are unimportant—or even less important. Rather, they serve as a warning that the failure to properly stress benefits of importance to the target population (e.g., financial benefits to truckers) may mean that those benefits of importance to the sponsor (e.g., sustainability benefits) will not be achieved. These findings may be generalizable to other contexts, especially low-paying, low-profitability firms and industries.

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MIS Quarterly

SPECIAL ISSUE: IS & ENVIRONMENTAL SUSTAINABILITY

ASSESSING THE EFFECTS OF BENEFITS AND INSTITUTIONAL INFLUENCES ON THE CONTINUED USE OF ENVIRONMENTALLY MUNIFICENT BYPASS SYSTEMS IN LONG-HAUL TRUCKING

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Appendix A

A Typical Bypass System Process

Figure A1 illustrates how bypass systems operate. Drivers and/or companies who subscribe to a commercial bypass service install wireless transponders (serving as the sensors for the network) onto the windshield of their trucks. Transponders are provided free of charge by the bypass system company. As the truck approaches a weigh station equipped with the corresponding bypass system, information pertaining to vehicle weight is transmitted to the station. The receivers are mounted on elevated "booms" positioned over the highway between one half-mile to one mile before the station (point 1 in Figure A1). Truck and driver data are forwarded to the weigh station (point 2) and checked for compliance. If the weight, driver service hours, and other data are within acceptable limits, then a signal is sent to and broadcast from a second elevated boom (point 3) that illuminates a green light on the truck's transponder giving the driver permission to bypass that station (point 4). If data are not acceptable, a signal illuminating a red light is broadcast (at point 3) and the driver must pull into the weigh station (point 5). Trucks may still be selected for a random inspection (point 2), resulting in a red light appearing on the transponder (point 3) and a required stop for the driver (point 5) (Regan et al. 2006). Conversely, all trucks without transponders are required to stop at the station for inspection. As with the transponders, the bypass system company furnishes and installs the receivers for the state transportation agencies. The only costs to the users are the monthly subscription fees for the service that are marketed to carriers or to individual drivers. Subscriptions are available only to carriers or individual drivers with good safety records.

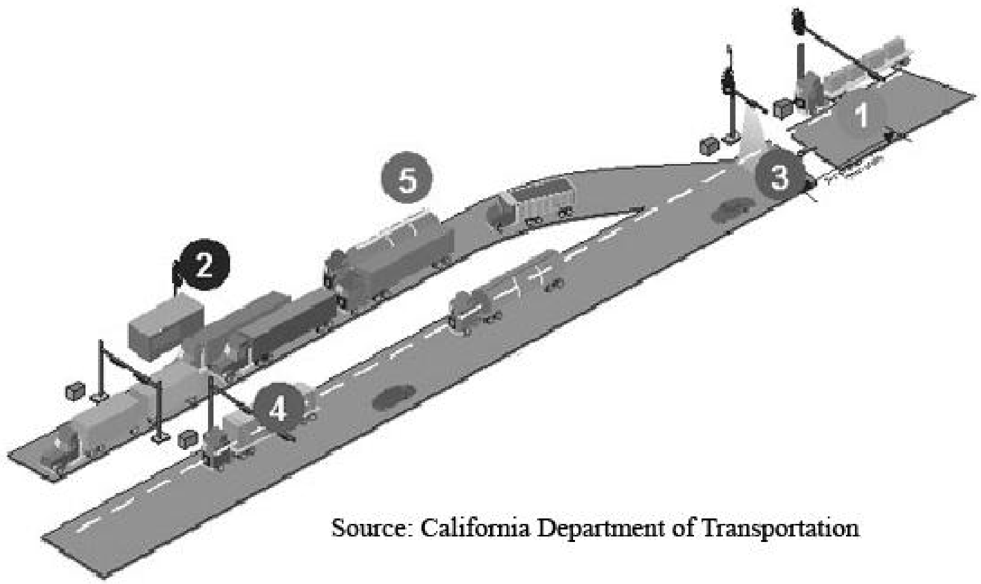

Figure A1. A Typical Bypass System Process

Appendix B

Measurement Items

Establishing content validity is mandatory for formative models (Petter et al. 2007). As is common in IS research, whenever possible we used scales that have been validated in previous related studies. However, because the benefits of a bypass system are relatively specific to that information system, it was necessary to develop items reflecting those benefits. Thus, the websites of bypass system developers, promotional materials, newsletters, and industry trade journals were reviewed for any potential benefits to drivers resulting from the use of bypass systems. The search resulted in a total of 16 potential benefits.

It was also important to assess whether formative measures fully capture the domain of a construct (Petter et al. 2007). This was done through both expert validation and a card sorting procedure (Straub et al. 2007). Once a set of potential benefits had been compiled from the materials described above, the instrument was reviewed separately by seven managers at two different regional trucking companies. The researchers met with the managers either in person or by telephone, and solicited their opinions as to the appropriateness of the items and the completeness of the survey. This led to several minor revisions to wording and clarification of certain terms. Next, four researchers not associated with the current study independently performed a card sorting exercise, placing each potential benefit in one of the hypothesized categories of benefits. An assessment of inter-rater reliability produced a kappa statistic of 0.82, which indicates overly substantial agreement (Landis and Koch 1977). Six benefits were dropped because they either could not be reconciled or were considered too similar to another benefit. As a result, 10 potential benefits were matched to the constructs displayed in the research model.

Because formative measures are not expected to be as interrelated as reflective measures (Götz et al. 2010), their validity can be assessed by the weights of their indicators. Upon initial assessment, one item associated with financial benefits, *reduced maintenance costs*, carried a negative weight, which suggests the item may have a suppression effect on the construct (Cenfetelli and Bassellier 2009). Since that item was also not significant to the construct, it was culled, resulting in a four-item measure of financial benefits. Several other formative items were not significant to their associated factors, but were not removed because doing so would threaten the already-established content validity of the construct (Petter et al. 2007).

Table B1. Measurement Items			
Construct	**Items**		**Sources and Additional Literature Support**
Benefits	**Below is a list of benefits provided by bypass systems. How important is each of these to you?**		
Environmental Benefits (Formative)	Env1 Env2 Env3	Paper reduction Reduced traffic congestion Reduced truck emissions	adapted from Chwelos et al. (2001)
Financial Benefits (Formative)	Fin1 Fin2 Fin3 Fin4 Fin5*	Reduced fuel costs Reduced insurance rates Reduced paperwork costs Time savings Reduced maintenance costs	adapted from Chwelos et al. (2001)
Accessibility (Formative)	Acc1 Acc2	Large number of weigh stations offering "system" capability Automated gate access to terminals	adapted from Chwelos et al. (2001)
Institutional Pressures			
Competitive Pressure (Reflective)	Comp1 Comp2	I feel a lot of pressure to use "system"[a] because drivers from other companies use it. "System"[a] helps me remain competitive.	Chwelos et al. (2001); Premkumar et al. (1997); Zhu et al. (2004)
Participation Among Other Drivers (Reflective)	Part1 Part2	What percentage of your company's drivers do you believe use the "system"? (%) What percentage of all drivers do you believe use the "system "? (%)	adapted from Teo et al. (2003)
Organizational Pressure	Org1	I use "system" because my company wants me to	Premkumar and Roberts (1999); Zhu and Kraemer (2005)
Industry Pressure (Reflective)	Ind1 Ind2	Number of times a year receiving promotional material from "system" company (#) Number of times a year receiving promotional material about "system" from professional organizations or trade newsletters (#)	adapted from Chwelos et al. (2001)
Dependent Variable			
Intention to Continue Use (Reflective)	Use1 Use2	I would not drive for a company that doesn't use "system" I won't subscribe to "system" unless the company reimburses me (RC)	developed for this study (see below)

Notes: All scales range from 1 (strongly disagree or not at all important) to 7 (strongly agree or extremely important). * = Dropped from the measurement model. % = arcsine transformed. # = Continuous, square-root transformed. RC = reverse coded. [a]The name of the commercial bypass system has been redacted.

A Long-Term Orientation for Continued Use of a Bypass System

While previous research has offered a great deal of insight into expectancy-based predictors of post-adoption system usage for employees (e.g., Bhattacherjee and Premkumar 2004; Venkatesh et al. 2011), various "life factors" can influence a user's intention to continue using an information system beyond factors associated with the system itself (Hsieh et al. 2011). In the current study, the employment realities for drivers in the commercial transport industry demanded additional consideration when selecting items reflecting the dependent variable in this study, intentions to continue use of a bypass system, which we discuss below.

The issue of voluntary turnover among long-haul drivers has long been of interest both to the industry and to academic researchers (see Taylor 1991; Taylor and LeMay 1991). Because continued use implies a long-term intention on behalf of the system user, we sought to acknowledge both the high turnover rate in the industry (estimated to be around 121 percent annually) and the temporary company affiliations of owner-operators who composed a significant portion of the sample. Additionally, these high turnover threats will undoubtedly be exacerbated by the expected long-term shortfalls in the supply of new long-haul heavy-duty truck drivers (e.g., supply and demand are forecast to grow at average annual rates of 1.6 percent and 2.2% percent respectively, over the next ten years; Global Insight 2005). Consequently, it seems reasonable to assume that a useful milestone is the driver's next job. This framework allowed us to gather data not only in a long-term context, but also from truck drivers who constituted an important subpopulation with relevant perceptions and intentions concerning bypass systems. The company managers with whom we consulted agreed this issue should be reflected in the survey.

Another reason for our long-term view on intention to continue use relates to the long-standing dynamic relationships among drivers, bypass systems, and other stakeholders. For example, some drivers question the motivation of the government-industry partnerships that implement bypass systems within the supply chain infrastructure. Despite assertions to the contrary by transportation and bypass system officials, many drivers suspect that these systems track drivers' speeds and hours of service. If, at some future date, these systems are used to monitor drivers, then these dynamic partnerships will change in negative ways for users well beyond the adoption phase (Riggins and Mukhopadhyay 1994). Similar comments can be made about changes in competition and legislation that occur after adoption, which will undoubtedly arise given the long-term horizon of sustainability issues (Hollander 1992). For instance, new changes in driver hours of service rules went into effect in February 2012 that makes it easier to charge drivers with "egregious" violations (which entail very large fines). This is likely to exacerbate the fears of some drivers that bypass systems are monitoring their movements. Continued usage intentions thus provide a foundation from which to explore usage decisions made in dynamic environments in which the ultimate user may be adversely affected.

Finally, capturing a long-term perspective of system usage seems especially important in the context of sustainable information systems because of the potential for discontinued use after initial adoption. Work in the area of environmental policy suggests that system initiatives can fail after adoption if financial, social, and system costs to the user become unreasonable, encouraging users to switch to suboptimal systems or, worse, to return to environmentally damaging practices (del Río et al. 2010; Jaffe et al. 2005). Such costs have been an issue in the slow deployment (and in cases, outright abandonment) of some traffic optimization systems meant to improve congestion (Casey 2000).

The two items measuring the dependent variable were USE1 and USE2. Each was measured using a seven-point Likert scale. The graph in Figure B1 visually depicts how the two items allowed us to capture both a high intention and a low intention to continue using a bypass system. (For the reader's convenience, the wording for the reverse-scored USE2 has been rephrased.) A driver who agrees with both USE1 and the rephrased USE2 indicates a high intention to continue use, meaning that the driver will not drive for a company that does not support the system, and that the driver may subscribe to the system if the company does not reimburse. On the other hand, a driver disagreeing with both items would have low intention to continue use, meaning that he or she does not insist the current company or any future company to support bypass systems, nor does the driver intend to subscribe on his or her own.

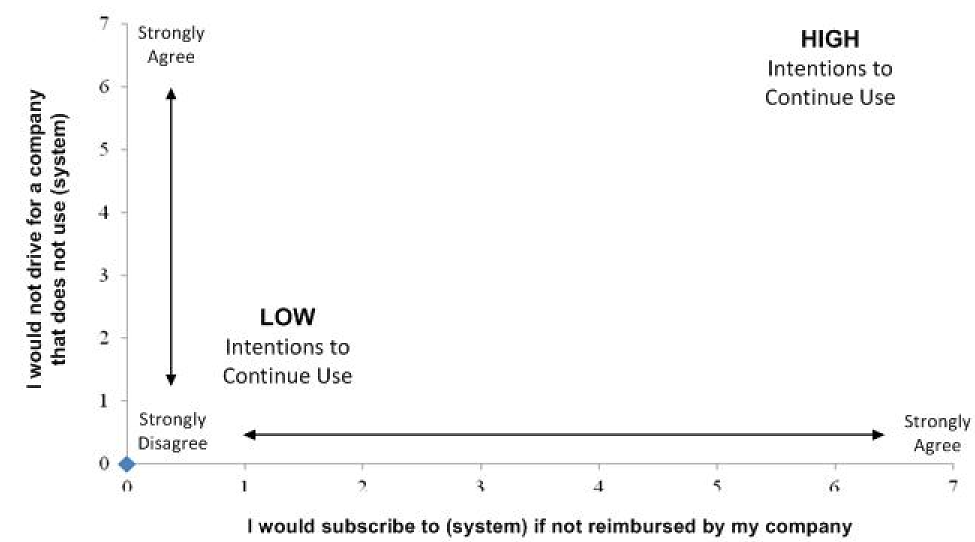

Figure B1. Items Measuring Intentions to Continue Using a Bypass System

Appendix C

Survey Participants

Survey respondents were from 24 states, ranging east-west from Virginia to California and north-south from Michigan to Florida. As an incentive for their participation, drivers who completed the survey were entered in a drawing for $100 gift cards from a large national retail chain. Drivers either completed surveys on site or returned them by mail. A total of 249 surveys were received, resulting in a response rate of 35.7 percent. The data from 11 respondents were either incomplete or violated a response set item included in the instrument ("Please circle neutral for this item") and were discarded. Similarly, 26 surveys were received from drivers who had never used a bypass system, and were likewise not included in the analysis. That left a sample of 212 useable survey responses.

It should be noted that there are two categories of truck drivers: company drivers and owner operators. Company drivers are employees of the carrier. While some carriers pay the bypass system costs for drivers, others do not. Owner operators meet the legal definition of independent contractors, which means they have a contractual relationship with the carrier, drive their own tractors, and are responsible for all maintenance and fuel costs, as well as all licenses and taxes necessary to operate these vehicles.

Table C1. Summary of Sample Demographics

Age	Sample	National	**Type of Driver**	
Mean	47.0 years	40.5 years	Company Driver	66.0%
SD	13.7		Owner-Operator	34.0%
Range	21 to 74 years			
Sex			Mean	17.6 years
Male	91.5%	88.4%	SD	12.3
Female	8.5%	11.6%	Range	< 1 to 55 years
Race			**Tenure with Current Company**	
U.S. Caucasian	70.2%	67.5%	Mean	5.4 years
African-American	23.1%	12.9%	SD	5.9
U.S. Hispanic	4.2%	15.8%	Range	< 1 to 36 years
U.S. Indian/ Pacific Islander	1.9%	n/a	**Experience with Bypass System**	
Multi-Ethic	0.5%	n/a	Mean	4.5 years
			SD	3.9 years
n = 212			Range	< 1 to 15 years

Note: National trucking demographics provided by a 2010 Bureau of Labor Statistics survey.

Appendix D

Reliability and Validity Assessments

Table D1. Interconstruct Correlations and Reliabilities

Measure	Mean (SD)	ICR	Env Ben	Fin Ben	Acc	Comp Press	Part	Org Press	Ind Press	Int Cont Usage
Environmental Benefits	4.9 (2.0)	n.a.	**n.a.**							
Financial Benefits	5.0 (1.7)	n.a.	.53	**n.a.**						
Accessibility	4.3 (2.1)	n.a.	.41	.30	**n.a.**					
Competitive Pressure	5.3 (1.0)	.72	.46	.51	.25	**.72**				
Participation (Others')	0.8 (.49)	.74	.15	.11	.07	.10	**.71**			
Organizational Pressure	4.9 (2.2)	n.a.	.04	.02	-.06	.17	.10	**n.a.**		
Industry Pressure	0.9 (2.2)	.71	.05	.22	.01	.10	-.05	-.07	**.73**	
Intention to Continue Usage	4.2 (1.6)	.71	.30	.41	.33	.33	.22	-.06	.16	.74

Note: Square roots of the AVE for each construct are bolded in the diagonal.

Table D2. Factor Loadings for Reflective Measure Items

Item	Competitive Pressure	Participation Among Other Drivers	Industry Pressure	Intention to Continue Usage
Comp1	0.75	0.09	0.07	0.25
Comp2	0.71	0.05	0.07	0.23
Part1	0.03	**0.76**	0.11	0.14
Part2	0.04	**0.68**	0.02	0.14
Ind1	0.09	0.04	**0.61**	0.15
Ind2	0.08	0.04	**0.83**	0.05
Use1	0.30	0.34	0.10	**0.87**
Use2	0.16	0.11	0.13	**0.59**

Table D3. Standardized Outer Weights for Formative Measure Items					
Construct	**Item**	**Weight**	**t-stat**	**VIF**	**Item-to-Construct Correlation**
Environmental Benefits	Env1	0.08	1.00	2.12	0.76*
	Env2	0.43*	3.32	1.67	0.67*
	Env3	0.06	0.49	1.51	0.81*
Financial Benefits	Fin1	0.11	1.72	1.57	0.73*
	Fin2	0.08	0.79	1.78	0.80*
	Fin3	0.07	0.53	1.98	0.80*
	Fin4	0.59*	4.20	1.44	0.50*
Accessibility	Acc1	0.43*	3.53	1.18	0.61*
	Acc2	0.08	0.65	1.36	0.85*

*Significant at .05 level

Because the data were collected from a single source (i.e., an individual driver) at a single point in time, common method bias could unduly sway the results (Podsakoff et al. 2003). We attempted to mitigate the bias *a priori* by counterbalancing the order of items and ensuring respondent anonymity (MacKenzie et al. 2011; Podsakoff et al. 2003). Additionally, once the data were collected, we assessed the model for common method bias, first using the unmeasured latent method construct (ULMC) approach for formative models (Liang et al. 2007). The method loadings were not significant for any of the indicators, and the substantive variances were larger than the method variances for all variables, providing evidence that common method bias was unlikely to be of consequence. Following that, a correlation analysis of the items in the research model and the response set item serving as a marker item was conducted. The average correlation of each item with the marker for all respondents was 0.05, with none of the correlations significant, providing further evidence that common method bias was minimal.

The data were assessed for internal validity by comparing the responses of early responders to those of late responders. As there had been no major contextual changes over the time period for data collection (such as drastic increases in fuel costs or new promotional efforts from the bypass system developers), there were no significant differences in the variables, as we expected. Finally, we tested the variables for differences between company drivers and owner operators to determine if a control variable was necessary. The data did not indicate any significant differences between the two types of drivers.

Although the sample size used in this study meets the standard rule for a minimum of 10 times the number of data points per incoming path to the construct with the most incoming paths, a more accurate assessment using power tables is recommended (Goodhue et al. 2012). A *post hoc* analysis indicated the statistical power provided by the sample was well in excess of the 0.80 specification.

Appendix E

Summary of Structural Equation Model

Factor	Beta	Standard Error	Confidence Interval (95%)		T-value	p
			Lower Bound	Upper Bound		
H1 Environmental Benefits	0.02	0.07	-0.16	0.11	0.34	0.73
H2 Financial Benefits	0.24	0.11	0.03	0.46	2.61	0.01
H3 Accessibility	0.20	0.07	0.07	0.34	3.05	0.01
H4 Competitive Pressure	0.16	0.07	0.02	0.30	2.18	0.03
H5 Participation of Other Drivers	0.20	0.11	0.00	0.41	2.18	0.03
H6 Organizational Pressure	-0.03	0.06	-0.14	0.08	0.50	0.62
H7 Industry Pressure	0.12	0.05	0.02	0.21	2.63	0.01

Following the precedent of Chwelos and colleagues (2001), the research model was tested with two additional versions, one with all formative constructs and one with all reflective constructs. Similar results were obtained in both circumstances, with none of the relationships gaining or losing statistical significance from those of the main analysis, suggesting that the results of hypothesis testing were not based on modeling decisions.

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