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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

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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.

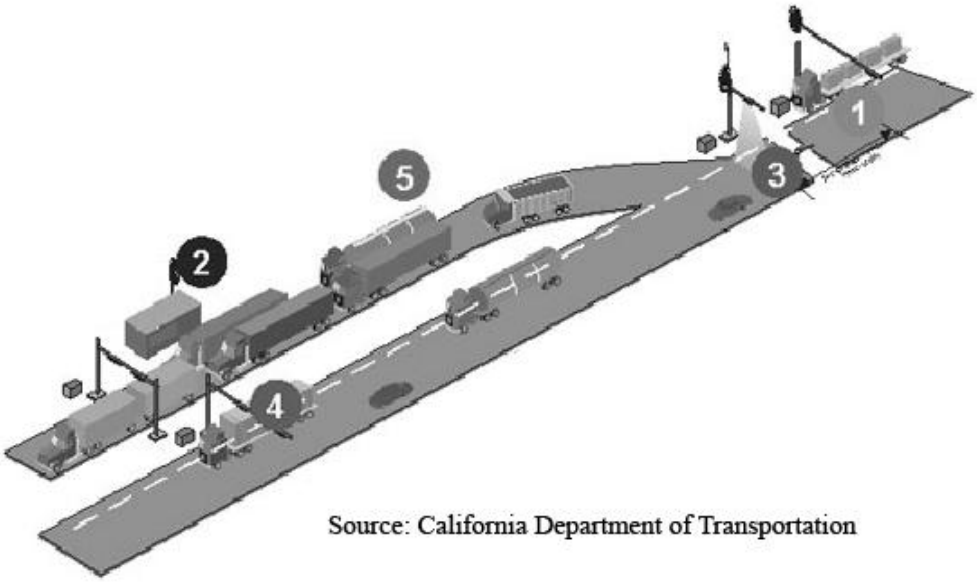

Figure A1. A Typical Bypass System Process

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.

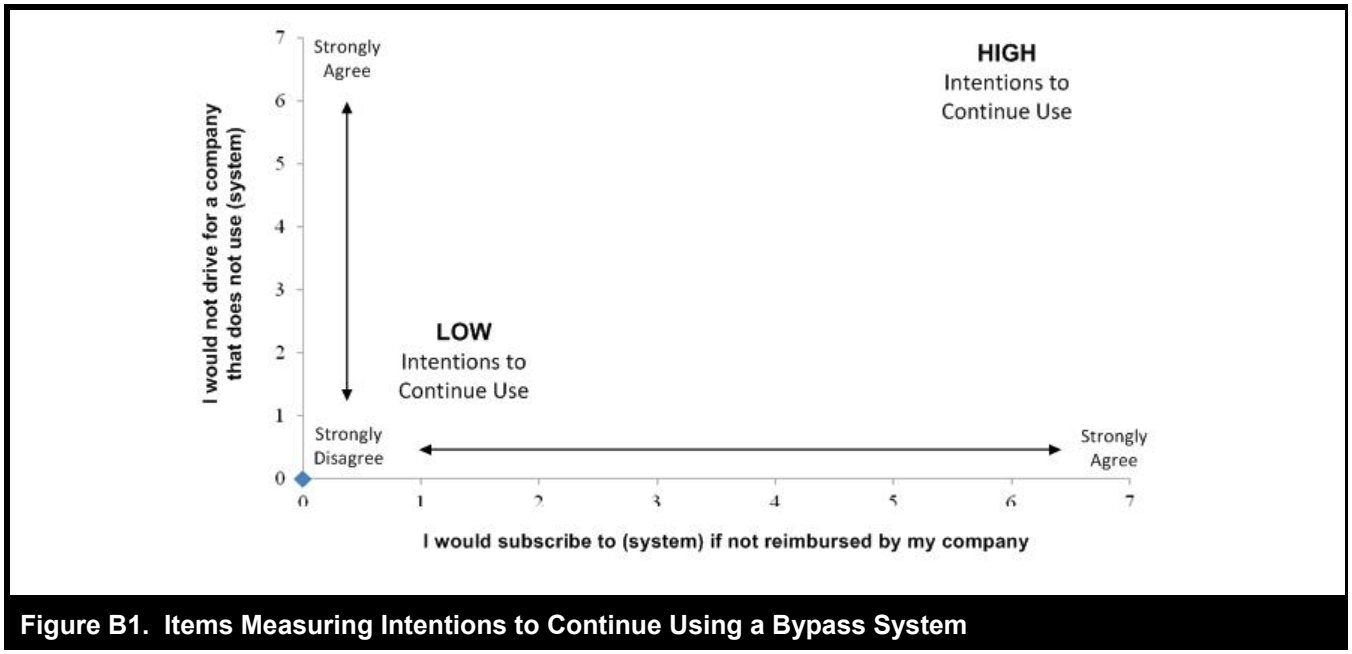

Figure B1. Items Measuring Intentions to Continue Using a Bypass System

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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