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Technology and Inter-Organizational Trust: Examining Determinants of Post-Adoption Utilization

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ABSTRACT

This study investigates the influence of technology trust and inter-organizational trust on first-tier supply chain members' post-adoption behavior toward a specialized information technology. Drawing upon past innovation diffusion research, a model is proposed and tested based on the Technology Acceptance Model. Field interviews followed by a mail survey were used to collect data from 273 first-tier supply chain members of the second largest U.S. automotive service parts logistics operation. A structural equation model tested the hypothesized relationships confirming the model's structure. Technology trust and inter-organizational trust have an effect on perceived ease of use and perceived usefulness that further affect technology utilization. Implications of this study along with suggestions for future research are provided.

INTRODUCTION

Significance of This Research

In 1997, the U.S. automotive industry valued their shipments in excess of $95 billion and spent over $66 billion on materials [1]. The global market for spare parts in the automotive industry currently exceeds $900 billion [2] of which a portion of the annual transportation costs are managed by third-party logistics firms (3PL). Schneider Logistics, a major 3PL, asserts that its automated logistics operations annually manage $5.4 billion in product transportation for the U.S. automotive industry alone [3]. Managing inventory movement is costly [4] and requires information technologies (IT) to reduce expenses and manage operational activity [5].

IT solutions, such as the Collaborative Visibility Network (CVN), are implemented by supply chains to provide detailed line-item identification of inbound materials to manufacturing facilities [5]. CVN, the technology investigated in this study, enables part-level visibility to supply chain members as goods are moved from supplier to distribution center. CVN benefits all supply chain affiliates through: (1) gaining improved inventory control; (2) reducing carrying costs; (3) reducing out-of-stock scenarios; (4) establishing visibility; (5) enabling changes to manufacturing schedules; and, (6) increasing customer satisfaction through improved order fulfillment [3]. General Motors, Ford North America, Ford Europe, and Saturn use Internet-based applications to coordinate activities, enhance inter-organization communication, and to develop better integration among supply chain partners [6].

In order for these solutions to provide business value, all supply chain affiliates must timely, accurately, and comprehensively input data. The absence or inaccuracy of data elements can affect multiple supply chain partners who make decisions based on the data contained within the system. This dependence upon others to function consistently and responsibly in their data processing behavior requires inter-organizational trust among supply chain partners. Since technology trust represents an individual's willingness to trust an information system, the level of trust affects organizational efficiency. Inter-organizational trust is necessary for supply chain members to willingly input data even when the new business process requires more time than previous manual procedures. The level of trust supply chain affiliates place in the technology used to coordinate activities and enhance communication among their partnerships can influence the success of their long-term interactions [7]. As such, understanding the degree to which inter-organizational and technology trust influences a supply chain member's decision to continue using an IT is of value to automotive support organizations that depend on supply chain partners to fully use a technology.

Contributions of This Research

This research makes two contributions to industry managers and information technologists by: (1) determining the effect of trust antecedents (inter-organizational trust and technology trust) and cognitive antecedents (perceived ease of use and perceived usefulness) on technology utilization; and, (2) providing recommendations for supply chains to encourage greater and continued technology usage.

This manuscript makes three contributions to the IT literature through: (1) proposing a conceptual model to investigate individual level determinants of post-adoption behavior; (2) providing a measure to evaluate utilization; and, (3) integrating the role of the supply-side into the diffusion framework since the model fails to address supply-side factors in IT usage [8].

LITERATURE REVIEW

The Technology Acceptance Model (TAM) ([9], [10]) was developed to explain and predict acceptance behavior toward a new technology, independent of user population and the technology being introduced. TAM posits that adoption decisions are predicated on an individual's attitude toward using the innovation and is premised on two salient beliefs: (1) perceived ease of use (PEOU); and, (2) perceived usefulness (PU). Gefen et al. [11] emphasize that TAM is theoretically important to IT research since TAM explains computer usage behavior and offers insights regarding how user acceptance is influenced by system characteristics.

According to TAM, perceived ease of use, which functions as an indicator of the cognitive effort needed to learn and use the new system, influences acceptance through its effect on perceived usefulness [10]. Several studies ([9], [10], [12], [13]) found PEOU to be an important determinant of IT adoption. The relationship between PEOU and PU and the impact on an individual's intention to adopt a technology were studied within the IT domain ([14], [15]). Prior studies examined antecedents to PEOU and PU including users' prior similar experience [16], personal innovativeness [17], computer experience [18], and support achieved through training [19]. PEOU and PU explain approximately 40% of why an individual uses a new technology [20].

Researchers investigating technology adoption using TAM as a theoretical basis have focused primarily on an individual's intention to adopt as the dependent variable ([10], [21], [22], [23]), rather than dependent measures of actual usage behavior. Intention to adopt represents the intent to behave in the future rather than an actual present behavior [24]. Actual usage behavior was studied in the form of post-adoption beliefs ([25], [26]) and computer utilization ([27], [28]). A fundamental premise to the proposed model is the notion that using a behavioral post-adoption approach to investigate actual technology utilization represents a more robust measure of IT usage and acceptance than an individual's intention to behave in the future.

RESEARCH MODEL

Based on TAM, it is suggested that an individual's utilization of a new technology in a socially dependent environment will be influenced by the degree of technology trust and inter-organizational trust, perceived ease of use and perceived usefulness of the technology.

Trust Constructs

Inter-organizational trust is the extent to which one party has confidence in an exchange partner's reliability and integrity [29]. Inter-organizational trust is a foundational element of effective interactions among supply chain members. Inter-organizational trust between supply chain affiliates is important in order for technological solutions to provide value to all stakeholders. The level of trust placed in a technology used to coordinate activities and enhance communication among supply chain partners can influence the success of their long-term interactions with one another [7]. Technology trust is an individual's willingness to be vulnerable to a technology based on expectations of technology predictability, reliability and utility and influenced by an individual's predilection to trust technology [30]. As such, it is suggested that inter-organizational trust will directly influence an individual's trust in the technology and the technology's perceived utility.

H1a: Inter-organizational trust of supply chain members will positively affect an individual's trust in the new technology.

H1b: Inter-organizational trust of supply chain members will positively affect an individual's perceptions that the technology is useful.

Existing literature provides evidence of positive relationships between various types of trust [[7], [11], [30], [32]-[36]) and an individual's intention to adopt a technology ([11], [37]). An individual's trust evaluation of a technology is based on the synthesis of affective and cognitive input [38]. Since PU refers to the degree to which an individual believes that a particular technology will enhance her job performance [9], the individual's trust assessment will likely impact this perception. Likewise, since PEOU represents the degree to which an individual believes that a particular technology is effortless to use [9], trust in the technology should influence an individual's perception that a technology is useful. Ultimately, trust assessments will affect an individual's willingness to engage in utilization behaviors where utilization refers to the extent to which users take advantage of the most important operational features of the technology [31].

H2a: Technology trust will positively affect an individual's perceptions that the technology is useful.

H2b: Technology trust will positively affect an individual's willingness to utilize the new technology.

H2c: Technology trust will positively affect an individual's perceptions that the technology is easy to use.

Technology Acceptance Model Constructs

Perceived usefulness was found to be a significant mediating variable between PEOU and the behavioral intention to adopt an IT ([9], [13]). Many studies ([10], [14]) found that PU is a better predictor of behavioral intention to adopt than PEOU. Gefen and Straub [37] suggest that PU, rather than PEOU, may influence the individual's usage intention toward a specific IT. The effect of an individual's PEOU influenced by his PU toward the usage decision is substantiated by a number of studies ([19], [22], [37], [39]-[42]). Venkatesh and Davis [41] found that users' perceptions regarding the ease of use will positively influence the user's behavioral intentions to adopt that IT. Therefore, according to TAM, the following relationships are hypothesized:

H3a: An individual's perceptions that a technology is easy to use are positively related to perceptions that the technology is useful.

H3b: The degree to which an individual perceives the technology as useful is positively related to a willingness to utilize the technology.

H4: The degree to which an individual perceives the technology as easy to use is positively related to a willingness to utilize the technology.

Figure 1 summarizes the research model incorporating the hypothesized relationships for the antecedents of technology utilization.

METHODOLOGY

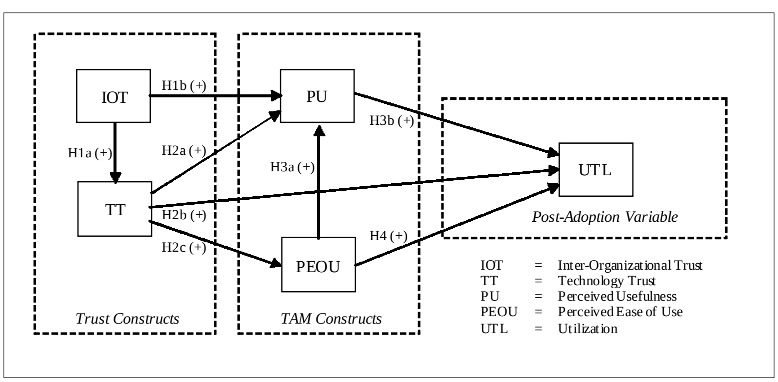
Technology under Investigation

The technology explored in this study, CVN, is a multidimensional IT developed used to provide part-level visibility to entire supply chains. Specifically, CVN is an Internet-based technology designed to facilitate a range of logistics functions particularly for shippers to schedule or confirm shipments ready for distribution to one of the automotive company's distribution centers in the United States.

Data Collection

The researcher conducted 58 two-on-one interviews with members of the second largest U.S. automotive supply chain over a four-month

Figure 1. Proposed Model



period in five U.S. geographic regions. These interviews were undertaken in order to understand the user population, to provide a foundation for survey design and development, and to serve as a data validation mechanism during the survey analysis stage. Based on these interviews, a survey instrument was developed.

The survey instrument was pre-tested and disseminated as the main data instrument. Since a similar version of this instrument was pre-tested, pilot-tested, and used in another automotive supply chain study, only a pre-test was performed with this version of the instrument. Eight members of the 3PL at various organizational levels previewed the instrument and offered minor wording modifications which were incorporated into the final questionnaire.

The 3PL Chief Information Officer sent a letter to the second-largest automotive first-tier supply chain membership indicating that a survey was forthcoming and seeking participation. Separately, participants received the survey, a postage-paid return envelope, and the researcher's cover letter explaining the study's purpose. Both cover letters promised confidentiality and indicated that a researcher from a specified north-east U.S. business school was conducting the investigation. Each survey was addressed to specific CVN user based on a contact list developed, maintained, and verified by the 3PL. The list included all individuals authorized to use the IT. A reminder on the login page and a follow-up email were employed.

Measures

Established measures were used to examine supply chain members' perceptions of their experiences with CVN. A seven-point Likert-scale was used to measure the study constructs with response options ranging from strongly disagree to strongly agree. PEOU was measured by six-item measures adapted from Davis [9] representing the degree to which an individual believes that a technology is effortless to use. PU was assessed by eight-items adapted from Davis [9]. Technology trust was measured by four-items based on the work of Lippert [30]. Inter-organizational trust was assessed by the eight items developed by Doney and Cannon [43]. Utilization was measured by a six-item scale adapted from Lippert and Forman [31].

Sample

A census was conducted to ensure that all qualified members of the authorized CVN user population received a survey. In total, 3,000 surveys were distributed; 562 were returned for incorrect addresses. The original contact list obtained from the 3PL contained numerous address errors impacting the number of returned questionnaires. After removing incomplete surveys from the 341 returned, 273 usable surveys were included in this study.

Respondents were primarily female, middle-aged, and possessed limited education with no participants indicating completion of graduate coursework or a graduate degree. Participants varied in gender (female, 65%; male, 35%); age (20-29 years of age, 12.1%; 30-39 years of age, 33.1%; 40-49 years of age, 37.1%; 50-59 years of age, 16.5%; and over 60, 1.1%), and education (high school diplomas, 19.0%; some college, 44.3%; college degree, 33.7%; other, 2.9%).

DATA ANALYSIS AND RESULTS

Measurement reliability was assessed through Cronbach's alpha ([44], [45]) and tests for construct validity. Table 1 displays the means, standard deviations, alphas, and correlations.

The construct alphas were well above the acceptable threshold of 0.7 set by Nunnally [46] and are considered strong measures with alphas ranging between 0.84 and 0.98 (see [47], [48]). The UTL1 item was dropped from the utilization construct and analysis due to cross-loading resulting in a five-item scale with ± = .84.

A factor analysis was conducted to determine if the constructs were indeed distinct and unique. A principal components factor analysis with a varimax rotation was performed on the thirty-one items used to measure PEOU, PU, TT, IOT, and UTL. Table 2 shows that there is minimal cross-loading and that each item loads on a unique factor. Additionally, 79.76% of the variance is explained. Therefore, construct validity is supported.

A structural equation modeling approach with maximum likelihood estimation was used to evaluate the hypotheses. The structural equation model using a series of hypotheses identifies how the variables are generated and related [49] and provides an assessment of predictive validity ([50], [51]). LISREL was selected for this type of data analysis since the model fit to the data is evaluated through the significance of the individual causal paths.

Hypothesized Structural Model

The research model was tested with an item-level structural equation model. Fit indices indicated that the model fit the data well, $Ç^2_{2.98}$ (N = 273) = 2, NNFI = .987, IFI = .997, CFI = .997, RMSEA = 0.2, SRMR = .04. Since the chi-square test statistic is sensitive to multivariate normality when sufficiently large sample sizes are used and produces unstable results when there is a violation of this basic statistical assumption [52], the use of other fit indices is warranted ([53], [54]). Thus, in addition to the statistical evaluation of fit using chi-square, CFI, NNFI and IFI over .90 are considered as criteria of good fit [55]. These three indices improve the fit of the hypothesized model over the null model, in which all observed variables are specified as uncorrelated. These thresholds have been found to be sufficient criteria even in small sample situations ([54], [56], [57]). Browne and Cudeck [58] suggest that an RMSEA of .05 or less indicates a close fit. The SRMRs less than .05 indicate a good fit to the data [59]. All SEM analyses were performed with covariance metrics as suggested by ([60], [61]). Table 3 summarizes this study's findings.

This study found that inter-organizational trust was significantly and positively related to technology trust and perceived usefulness. Trust in supply chain partners influences an individual's trust in technology and perceptions that the new technology is useful for specific job tasks. Technology trust affects an individual's perception that the technology is easy to use and useful for task completion. Trust in the technology appears to directly affect an individual's IT utilization. Within a supply chain context, PEOU was confirmed to influence PU and provides further support of this relationship. Perceived usefulness was found to influence an individual's utilization of the technology. However, PEOU was found to negatively influence technology utilization producing a

Table 1. Means, Standard Deviations, Correlations, and Reliabilities

Means, Standard Deviations, Correlations and Measures of Reliability Among the Variables (n = 273)

	Mean	S.D.	1	2	3	4	5
1. Perceived Ease of Use	4.91	1.57	(.96)				
2. Perceived Usefulness	3.71	1.90	.61*	(.98)			
3. Technology Trust	4.58	1.55	.60*	.62*	(.95)		
4. Inter-Organizational Trust	4.51	1.24	.33*	.41*	.42*	(.94)	
5. Utilization	1.47	0.92	.14**	.28*	.21*	.15**	(.84)

* Correlations are significant at the 0.01 level ** Correlations are significant at the 0.05 level.

Table 2. Factor Analysis of Study Constructs

	Factor 1 Perceived Usefulness	Factor 2 Inter-organizational Trust	Factor 3 Perceived Ease of Use	Factor 4 Technology Trust	Factor 5 Utilization
PU1	**0.803**	0.144	0.355	0.215	0.136
PU2	**0.875**	0.207	0.228	0.168	0.117
PU3	**0.886**	0.175	0.211	0.177	0.122
PU4	**0.893**	0.188	0.201	0.178	0.106
PU5	**0.902**	0.192	0.207	0.144	0.108
PU6	**0.890**	0.204	0.218	0.187	0.107
PU7	**0.874**	0.166	0.268	0.192	0.108
PU8	**0.814**	0.182	0.310	0.266	0.131
IOT1	0.172	**0.731**	0.154	0.312	0.032
IOT2	0.171	**0.847**	0.044	0.216	0.008
IOT3	0.154	**0.783**	0.003	0.252	-0.034
IOT4	0.175	**0.828**	0.173	0.048	0.094
IOT5	0.159	**0.850**	0.180	-0.003	0.111
IOT6	0.132	**0.870**	0.156	0.001	0.075
IOT7	0.151	**0.865**	0.055	0.183	0.021
IOT8	0.089	**0.707**	0.038	-0.062	0.072
PEOU1	0.200	0.133	**0.864**	0.166	0.033
PEOU2	0.212	0.105	**0.881**	0.155	-0.003
PEOU3	0.436	0.170	**0.730**	0.179	0.066
PEOU4	0.233	0.109	**0.887**	0.166	0.009
PEOU5	0.304	0.129	**0.821**	0.241	0.064
PEOU6	0.381	0.120	**0.823**	0.223	0.051
TT1	0.248	0.208	0.287	**0.770**	0.078
TT2	0.337	0.142	0.282	**0.807**	0.110
TT3	0.368	0.207	0.315	**0.789**	0.083
TT4	0.357	0.213	0.290	**0.796**	0.087
UTL2	0.151	0.092	0.025	-0.006	**0.712**
UTL3	0.026	0.040	0.028	0.093	**0.825**
UTL4	0.104	0.116	0.024	0.069	**0.773**
UTL5	0.084	0.122	-0.003	-0.021	**0.819**
UTL6	0.126	-0.109	0.061	0.098	**0.695**
% of variance explained	44.74%	13.06%	9.59%	7.21%	5.15%

counter-intuitive finding. This finding may be explained by insights obtained during the interviews suggesting that supply chain members were resistant to embrace the technology. Within the automotive supply chain investigated, there was a perception that a more difficult process equates to a 'better' process due to the perceived complexity of the IT which may partially explain this finding.

DISCUSSION AND IMPLICATIONS

This research offers three contributions to the IT literature. First, a conceptual model was empirically tested to understand the influence of individual level determinants on post-adoption behavior. This study found that trust antecedents – inter-organizational trust and technology trust – and the cognitive antecedent – perceived usefulness – exhibited an affect on technology utilization. Second, a measure to evaluate logistics functionality of a specialized IT was employed and found to exhibit strong internal consistency. This suggests that this measure may be useful to investigate an individual's utilization of similar supply chain technologies. Third, this study investigated factors impacting post-adoption utilization of an information technology by supply chain organizations and thereby addressed supply-side issues of IT usage.

Table 3. Results of the Proposed Model

Causal Paths	Hypothesis	Standardized Structural Coefficient	t-value	Assessment
Inter-organizational trust → technology trust	H1a	.44	7.273*	Supported
Inter-organizational trust → perceived usefulness	H1b	.15	2.971**	Supported
Technology trust → perceived usefulness	H2a	.36	5.607*	Supported
Technology trust → utilization	H2b	.12	1.209*	Supported
Technology trust → perceived ease of use	H2c	.63	12.507**	Supported
Perceived ease of use → perceived usefulness	H3a	.35	5.965*	Supported
Perceived usefulness → utilization	H3b	.29	3.169*	Supported
Perceived ease of use → utilization	H4	-.10	-1.093*	Not Supported

* Parameter estimates are significant at 0.10 or less

** Parameter estimates are significant at 0.05 or less

This research makes two contributions to industry managers and information technologists. First, this study found that two forms of trust – inter-organizational and technology – appear to affect supply chain member continued IT utilization. This implies that industry managers should assess inter-organizational relationships to determine if high levels of trust exist. Identifying opportunities for supply chain affiliates to engage in positive trust activities can help foster and promote inter-organizational trust. Opportunities to build technology trust also appear to be important to supply chain affiliates in persuading members to use the technology. Second, supply chains should be encouraged to develop initiatives that foster greater continued IT usage through the application of trust initiatives.

FUTURE RESEARCH

Future research should investigate antecedents of technology trust and inter-organizational trust to understand the implications on IT utilization. Antecedents of technology trust and inter-organizational trust are likely to offer increased understanding of the technology adoption process and use of innovations. Additionally, technology trust and inter-organizational trust are well positioned for pragmatic application to supply chain organizations.

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