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Evaluating Supply Chain Context-Specific Antecedents of Post-Adoption Technology Performance

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ABSTRACT

This study investigated the influence of context-specific antecedents to user perceptions of technology performance using a new logistics information tracking technology designed to facilitate the linking of supply functions. Supply chain awareness, task-technology fit, and satisfaction with the existing system were evaluated as external variables likely to influence technology performance. This research examines the effect of these three constructs on technology acceptance as a function of post-adoption perceptions of technology performance. The research model was based on the original Technology Acceptance Model. Data from a mail survey were collected to evaluate 718 first-tier supply chain users' perceptions of a new technology's performance that includes accuracy, visibility, and efficiency. A structural equation model tested eleven hypothesized relationships. The results of this study advance understanding of technology adoption, enrich knowledge of technology innovation, and offer suggestions for enhancing user perceptions of technology performance. Implications along with suggestions for future research are provided.

Keywords

Post-Adoption Behavior, Technology Performance, Task-Technology Fit, TAM, Supply Chain Awareness

INTRODUCTION

Over the last sixteen years since the introduction of the Technology Acceptance Model (TAM) by Davis (1989), a large body of research has emerged that has integrated and investigated technology innovation, adoption, and use. However, given the depth and breadth of the literature, minimal research has been undertaken to examine technology diffusion within a supply chain context. Therefore, this study considers the impact of context-specific antecedents of user perceptions toward a new logistics information technology (IT) designed to facilitate the linking of supply functions.

Given supply chain interdependencies, diffusion of IT across supply chains is challenging. Effective IT implementation requires firms to adopt and ultimately continue using these innovations. Organizations consist of interdependent resources including human, technological, and fiscal that must function together within the context of various types of structures designed to meet specific organizational goals, objectives, and outcomes (e.g.

assuming a participative role in supply chains). Therefore, introducing a technology into supply chains can be problematic given the combinations of interacting organizational factors. As a consequence, context-specific antecedents are examined to determine their effect on usefulness, ease of use, and ultimately performance.

RESEARCH OBJECTIVES AND QUESTIONS

The purpose of this research is to investigate an expanded model of technology acceptance that differentiates the effects of three antecedent factors on supply chain users' perceptions of technology performance. The technology studied in this research is a specialized supply chain information systems application. Specifically, this study addresses two principle research questions:

- (1) To what degree are there differences in perceptions of technology performance within the framework of an existing behavioral model?
- (2) To what degree do the context-specific factors have influence on perceptions of technology performance?

LITERATURE REVIEW

The Technology Acceptance Model (TAM) was developed by Davis (1989) to explain and predict an individual's acceptance behavior toward a new IT, independent of the user population and the technology being introduced. Davis (1989) based TAM on the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975) and asserted that technology adoption decisions are based on an individual's affective reaction or attitude toward using an innovation. According to TAM, an individual's decision to accept a new technology is predicated on two beliefs: (1) perceived ease of use, the individual's perception concerning the amount of effort required to use the new technology; and, (2) perceived usefulness, the user's perception concerning the degree to which using the technology will improve his job performance (Davis, 1989). According to TAM, perceived ease of use, which functions as an indicator of the cognitive effort needed to learn and use a new system, influences acceptance through its effect on perceived usefulness (Davis, 1989). TAM is an important model of technology acceptance since the theory explains computer usage behavior and offers insights regarding how user acceptance is influenced by system characteristics (Gefen et. al., 2003).

Researchers have empirically validated TAM in a variety of settings with limited attention application within

supply chains. Prior studies have examined TAM antecedents including users' perceived risk (Wu & Wang, 2005) and tool experience (Dishaw & Strong, 1999). Although a large body of research exists on technology adoption, innovation, and use, research into the effect of supply chain awareness, task-technology fit and satisfaction with the existing system on IT acceptance within a supply chain context remain under-investigated. This study expands the application of context-specific antecedents to the investigation of effect on technology performance in the supply chain management domain.

MODEL DEVELOPMENT AND HYPOTHESES

Figure 1 summarizes the research model incorporating the hypothesized relationships. The model suggests that supply chain awareness, task-technology fit, and satisfaction with the existing system have an effect on perceived usefulness and ease of use, and therefore on an individual's perceptions of technology performance.

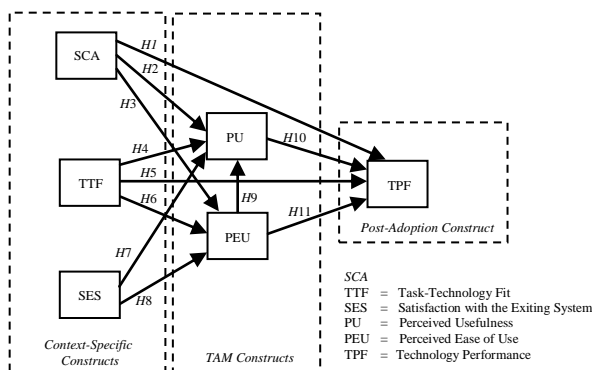


Figure 1. Research Model

CONTEXT-SPECIFIC CONSTRUCTS

Supply Chain Awareness

Forman and Lippert (2005) suggest that supply chain awareness is the degree to which an individual completely understands all the components, interactions, needs, process activities, and requirements of supply chain management. Holweg and Bicheno (2002) assert that understanding the dimensions and concepts associated with supply chain activities is critical if organizations are to effectively employ supply chain operations. The automation of supply chain activities can potentially impact the work environment if understanding of the supply chain process and the underlying task domains is limited. If individuals lack the fundamental knowledge of managed supply chains, then they are unlikely to positively evaluate a domain-specific solution. Individuals with a greater understanding of supply chain management will exhibit a deeper appreciation of the IT solution offered to automate supply chain activities. Therefore,

H1: The degree to which an individual has awareness of supply chain activities is positively related to his

perceptions of technology performance.

H2: The degree to which an individual has awareness of supply chain activities is positively related to his perceptions of the technology's usefulness.

H3: The degree to which an individual has awareness of supply chain activities is positively related to his perceptions of the technology's ease of use.

Task-Technology Fit

Goodhue and Thompson (1995) suggest that task-technology fit is the extent to which an IT provides features and supports a fit with the requirements of the task. Cooper and Zmud (1990) have shown support between fit and utilization of an IT at the organizational level. If the individual perceives that the IT adequately fits the required task, then a positive evaluation is rendered. The accumulation of these evaluations form an assessment of the level of fit the individual identifies with the technology. Goodhue and Thompson (1995) suggest that individuals may use technologies to aid in the performance of their tasks. Task-technology fit and the beliefs about the consequences of using a system impact IT utilization (Goodhue & Thompson, 1995). This suggests that if individuals evaluate the task-technology fit as it relates to the performance of their tasks, their evaluation will lead to a positive perception. Therefore,

H4: The degree to which an individual recognizes the task-technology fit of the new system is positively related to his perceptions of technology usefulness.

H5: The degree to which an individual recognizes the task-technology fit of the new system is positively related to perceptions of technology performance.

H6: The degree to which an individual recognizes the task-technology fit of the new system is positively related to perceptions of technology ease of use.

Satisfaction with the Existing System

Organizational members are becoming more dependent upon IT. As individuals develop technological expertise, their perception of the technology's performance will affect their overall level of satisfaction. Satisfaction with the existing system is the degree to which a system meets the needs of an organization within an acceptable cost threshold (Chau & Tam, 2000). If users are satisfied with their existing systems, they may experience more uncertainty trying to project how this new system will aid in the completion of daily tasks. As such, individuals may find it more difficult to identify the positive benefits of the new IT relative to the old system. Therefore, users of supply chain automation solutions are less likely to adopt and continue using the new solution due to their satisfaction with the existing systems. Therefore,

H7: The degree to which an individual is satisfied with the existing system is negatively related to his perceptions of the technology's usefulness.

H8: The degree to which an individual is satisfied with the existing system is negatively related to his perceptions of the technology's ease of use.

TAM CONSTRUCTS

Perceived Usefulness

Perceived usefulness was consistently found to be a significant mediating variable between perceived ease of use and the behavioral intention to adopt a technology (Davis, 1989; Lynn et. al., 2002). Therefore,

H9: The degree to which an individual perceives the technology as easy to use is positively related to his perceptions that the technology is useful.

Many studies (Gefen et al., 2003; Igbaria et. al., 1996) find that perceived usefulness is a better predictor of behavioral intention to adopt than perceived ease of use. Taylor and Todd (1995) suggest that intention to adopt an IT is influenced by performance-related outcomes in the workplace. This implies that if individuals perceive the IT to be useful, there will be a greater propensity to use the new technology. Therefore,

H10: The degree to which an individual perceives the technology as useful is positively related to his perceptions of the technology's performance.

Perceived Ease of Use

The post-adoption construct in this research model is technology performance which has been used as a dependent measure in other research (Pagell et. al., 2000) to understand the effects of operational skills on technology performance within a manufacturing context. Technology performance refers to the performance capabilities across multiple logistics functions including assessing accuracy, visibility, requirements, efficiency, quality, and performance related to customer satisfaction. Technology performance represents the individual's perceptions of how well an IT assists in performing tasks.

Jawahar's (2002) findings suggest that the perceived ease of use associated with a particular technology is positively related to higher performance. Additionally, Lippert and Forman (2005) found that an individual's recognition of the perceived ease of use of a technology is positively related to higher technology performance. Therefore,

H11: The degree to which an individual perceives the technology as easy to use is positively related to his perceptions of the technology's performance.

METHODOLOGY

Supply Chain Technology

The Collaborative Visibility Network (CVN), an Internet-based technology, is designed to provide visibility to supply chains in support of their logistics operations.

Survey Instrument Structure

A Likert-scale with seven-point anchors (strongly disagree to strongly agree) was used. Table 1 depicts the research constructs with the original scale sources.

Construct	Construct Definition	Number of Items	α	Scale Source
Perceived Ease of Use	<i>The degree to which an individual believes that a particular technology is effortless to use</i>	6	.94	Davis, 1989
Perceived Usefulness	<i>The degree to which an individual believes that a particular technology will enhance his job performance</i>	8	.98	Davis, 1989
Satisfaction with the Existing System	<i>The degree to which the existing system meets the needs of an organization</i>	3	.63	Chau & Tam, 2000
Task-Technology Fit	<i>The extent to which a technology provides features and support that fit the requirement of the task</i>	6	.84	Goodhue & Thompson, 1995
Supply Chain Awareness	<i>The degree to which an individual understands the supply chain management concept</i>	7	N/A	Forman & Lippert, 2005
Technology Performance	<i>The technology's (CVN) performance across multiple logistics functions</i>	6	.90	Lippert & Forman, 2005

Table 1. Research Constructs

Data Collection

A survey was sent to all the authorized users of CVN within the first-tier supply chain membership of the two largest automotive manufacturers in the U.S. A total of 6,348 surveys were distributed and 1,043 were returned; 718 usable surveys were included in this study yielding a response rate of approximately 11.3%.

DATA ANALYSIS

Demographics

Gender, locale (U.S. or Canada), and zip codes were collected (Table 2). Zip codes were collapsed into a binary nominal structure and labeled as rural or urban based on criteria from the U.S. Department of Commerce 2000 National Census (Department of Commerce, 2000).

Gender	Men		Women	
	282	39.3%	436	60.7%
Locale	U.S.		Canada	
	632	88.0%	86	12.0%
Geographic Areas	Rural		Urban	
	174	24.2%	458	63.8%
	86 are Canadian responses representing 12.0% of the sample			

Table 2. Demographics (N=718)

Analysis of Construct Validity and Reliability

Measurement reliability was assessed through the use of Cronbach's alpha and tests for construct validity. Table 3 depicts the means, standard deviations, alphas and correlations of the variables. The coefficient alphas for each construct were well above the conventional threshold of 0.70 (Nunnally, 1978). A factor analysis was performed to determine if the constructs were unique. Minimal cross-loading occurred resulting in support for construct validity.

	Mean	S.D.	1	2	3	4	5	6
1. Perceived Ease of Use	4.91	1.54	(.96)					
2. Perceived Usefulness	3.89	1.89	.64*	(.99)				
3. Satisfaction with the Existing System	4.90	1.57	-.32*	-.53*	(.83)			
4. Task-Technology Fit	4.31	1.60	.56*	.69*	-.40*	(.96)		
5. Supply Chain Awareness	4.56	1.52	.32*	.39*	-.17*	.44*	(.97)	
6. Technology Performance	4.26	1.62	.56*	.65*	-.29*	.62*	.37*	(.88)

* Correlations are significant at the 0.001 level

Table 3. Variable Statistics (N=718)

Analysis of Hypothesized Research Model

Figure 2 shows the path coefficients contained within the structural model. All fit indices exceeded the recommended levels established by theory.

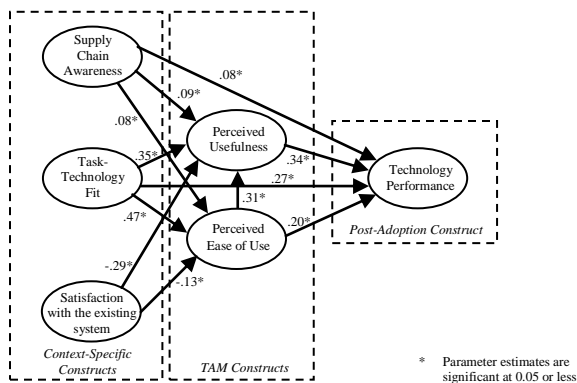


Figure 2. Structural Model

A structural equation modeling (SEM) approach with maximum likelihood estimation was used to evaluate the research questions. LISREL was selected for the data analysis since the model's fit to the data is evaluated through the significance of the individual paths. The research model was tested with an item-level structural equation model. Fit indices indicated that the model fit the data well, $\chi^2_{22.98}$ (N=718) = 1, NNFI = .982, IFI = .999, CFI = .999, RMSEA = 0.05, SRMR = .008.

Interpretation of Results

All eleven hypotheses were found to be significant at $p < .05$. Specifically, knowledge of supply chain awareness was found to be a predictor of technology performance, perceived usefulness and perceived ease of use. The findings suggest that there is a need for awareness of

supply chain activities in order for individuals to conclude that the technology is useful, easy to use, and perceive the functional capabilities of the system. Task-technology fit is an important predictor of the technology's perceived usefulness, technology performance, and perceived ease of use. Respondents found that if the technology fit the task well, the system was described as easy to use and useful.

Individuals suggested that when they were satisfied with the existing IT, they did not find the new technology to be useful or easy to use. This finding, although counter-intuitive to what might be expected, is consistent with what was hypothesized. Therefore, the perception of technology performance as a function of perceived ease of use and perceived usefulness is negatively affected by satisfaction with the existing information technology.

Consistent with existing studies (e.g., Karahanna & Straub, 1999; Venkatesh & Davis, 1996), perceived ease of use was found to predict perceived usefulness. Consistent with Lippert and Forman (2005), both perceived usefulness and perceived ease of use were found to be predictors of technology performance.

LIMITATIONS

Several limitations in generalizability, process, and method are noted for this study. First, this research was delimited to first-tier suppliers of two major U.S. automotive manufacturers, thus restricting external validity. Second, the inclusion of only first-tier suppliers could affect the study's generalizability with regard to second- or third-tier CVN users within this supply chain context. Third, since this research investigates the perceptions of only two supply chains, care should be exercised when extrapolating the results until the study is replicated across more diverse populations.

CONTRIBUTIONS AND IMPLICATIONS

This study helps to better understand the technology adoption process and has practical implications for logistics operations which are implementing or preparing to implement new IT. For new technology adoption, the efficiency and adaptation of users from an old logistics tracking system to a new one is directly related to implementation and operational costs. If organizations that are introducing an information system consider the antecedents and relationships from this study and develop metrics for assessing technology performance, it is predicated that the adoption of new technology will occur with reduced costs and dissatisfaction.

Managers of information systems should recognize that individuals' perceptions of technology performance and the antecedents can be modified and enhanced. As such, training programs designed to acknowledge the technology's functionality could be one way of manipulating users' perceptions toward the system. During the design process, task-technology fit must be a prime consideration. During testing and implementation,

users need to pay particular attention to increasing their overall knowledge of the supply chain process and operational functions. Finally, during pre-design and conversion from the old to the new system, a one-time measure of user satisfaction helps to identify those system components that affect the perceptions of ease of use, usefulness and finally technology performance.

FUTURE RESEARCH

This study is rich with opportunities to follow a number of paths of investigation to better understand the effects of context-specific antecedents to technology performance. Technology acceptance and continued usage are clearly affected by a diverse set of behavioral antecedents. Continued research to strengthen the understanding of the relationships between technology introduction and performance are both proposed and warranted.

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