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Table of Contents

Refereed Articles

Edited Articles

Student Articles

An Application of the Technology Acceptance Model to Intended Adoption of Digital Printing Technology in the Label Industry

by Bruce Leigh Myers, Ph.D. • Trevor Schroeder, M.S. • Rochester Institute of Technology

Production-level digital printing technologies have made significant inroads into many segments of the commercial printing industry. One particular segment which is especially well-suited for the adoption of digital printing is label printing. Despite this apparent fit, digital printing technologies have not been universally adopted by label printers.

The present study examines the intention to adopt digital printing through Davis' Technology Acceptance Model (TAM). Using a cross-sectional, quantitative survey, managers at label printing organizations were asked about their intention to adopt digital printing, as well as questions relevant to the constructs which comprise the TAM, namely, *Attitude*, *Perceived Usefulness*, and *Perceived Ease of Use*. The resulting data indicate a relative indifference regarding the constructs on the part of those label printers that do not intend to adopt digital printing, whereas intended adopters view the technology as easier to implement and befitting of a business model based on an expanded customer base.

Introduction

Digital printing technologies have made significant inroads into many segments of the traditional printing market. As technologies continue to mature, benefits such as faster turnaround time, personalization and more cost-effective short runs have combined to make digital printing an integral part of many printing operations (Myers, B., 2014).

One segment especially well-suited for digital printing technology is the label business. (McLoone, 2010). Digital printing technologies, however, have not been universally adopted by all label printers. While some plan on adopting digital printing for labels in the near future, others do not foresee digital printing in their immediate plans. Using the constructs of Davis' Technology Adoption Model (TAM) as a framework, this study examined the salient factors that separate intended adopters from those label printers that do not intend to adopt digital printing technology in the near future, including a discussion on the potential implications of these findings.

Need for the Study

Examining the adoption of innovations has been the primary focus of studies for over 100 years (Brown, 1981). This study attempted to build on this rich history while providing relevant information for both industry and researchers. From a practical standpoint, the research examines the factors that underlie the intention of label printers to adopt or to not adopt production-level digital printing technologies. The information is likely useful for those with a vested interest, including the vendor community, standards bodies, educators, buyers, and printers. In addition, the present research utilizes the TAM as a framework, and as such adds to prior research that focuses on an attitude/behavior perspective, which has proven to represent an especially powerful, yet simple, manner in which to predict user intentions (Gallion, 2000).

Literature Review: The Technology Acceptance Model (TAM)

The TAM was developed by Davis (1980), with the goal of explaining information technology usage behavior. An adaptation of Fishbein and Ajzen's Theory of Reasoned Action, the TAM utilizes three key constructs, namely *Attitude, Perceived Usefulness* and *Perceived Ease of Use*, which are theorized to influence Intention to Adopt, as illustrated in Figure 1.

Attitude toward adopting is defined as the prospective adopter's positive or negative feeling about the company's adopting industry specifications (Ajzen, 2012, Fishbein & Ajzen, 1975, 2010). As used in the present study, Attitude is an important component of the TAM, and is measured using a semantic differential scaling technique based on

The Technology Acceptance Model, adapted from Davis, 1980, 1989.

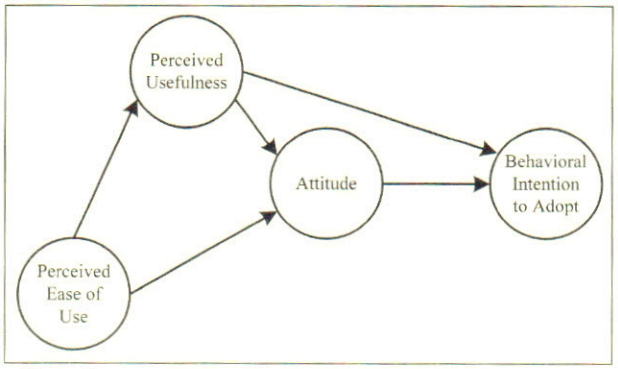

Figure 1

seminal work developed by Osgood, Suci and Tannenbaum in the 1950's, as cited in Fontaine, Scherer, and Soriano (2013) and Crano and Prislin (2010).

Perceived Ease of Use is defined as the degree to which the prospective adopter expects the adoption of industry specifications to be free of effort regarding its transfer and utilization (Davis, 1989, 1992). It is theorized to influence both *Attitude* and *Perceived Usefulness*, as instrumental improvements in ease of use may result in the increased performance of a respective innovation. *Perceived Usefulness* is defined as the prospective adopter's subjective probability that applying industry specifications will be beneficial to the adopting companies' wellbeing (Davis, 1989, 1992). *Perceived Usefulness* is theorized to influence both *Attitude* and *User Intention to Adopt*. Further, Davis, Bagozzi and Warshaw (1989) contend that there is a relationship between the constructs perceived ease of use and perceived usefulness, as illustrated in Figure 1.

One key criterion for selecting a theory to examine a phenomenon such as innovation adoption is parsimony: social researchers tend to prefer theories that utilize a minimum number of constructs (Dobbins, 1999). The TAM represents one such parsimonious model; it is generally regarded as simpler, easier to employ and less costly to apply than other such models (Myers, B.L., 2004).

Research Design and Methodology

In order to address the research question, a cross-sectional survey instrument was developed based upon previous studies utilizing the TAM. The questionnaire instrument was developed specifically for measuring the constructs which comprise the TAM, namely, Perceived Usefulness, Perceived Ease of Use, the direct Attitude measure, as well as Intention to Adopt. The survey was pilot tested among industry professionals and academics prior to administration. The goal of the survey process was to seek responses from label printers in the United States who were non-adopters of production-level digital printing technology. As no list of such companies was readily available to utilize as a sampling frame, the following procedure was employed to obtain the list of potential respondents:

A current *Hoover's* database was searched for "Commercial Printing" (except Screen and Books), "Located in the United States", and several relevant keywords. If the company in the resultant search had a website available, it was examined to ascertain if that particular organization was an appropriate candidate for the study. This process resulted in 160 companies. Companies identified by the *Hoover's* search that did not have available websites were placed in a separate category. One hundred of these companies without a found website were randomly selected to receive the questionnaire instrument.

There were 260 questionnaires mailed. Fifty-one were returned, resulting in a response rate of nearly 19%. Of these, 31 qualified for data analysis. Ten of the 31 indicated neither an intention to adopt or to not adopt digital printing technology in the next twelve months, eight respondents reported that they did intend to adopt, and 13 indicated that they did not intend to adopt within this time period.

Demographic information with regard to the size of the companies responding is presented in Table 1. Over 85% of the respondents indicated that their companies had fewer than 50 employees. Companies with 100 employees or more represented just fewer than 11% of the respondents.

Table 1: Respondent Demographics: Number of Employees (n=31)

Number of Employees	Percentage of Respondents
1 - 9	35.7%
10 – 49	50.0%
50 – 99	3.6%
100 – 199	7.1%
200 – 499	3.6%
500 or more	0.0%

Results

The direct measure of the *Attitude* construct consisted of four separate items, as shown in Table 2. Mean results indicated a generally positive outlook with regard to the adoption of digital printing technologies among intended adopters, whereas non-adopters were somewhat indifferent, with average values close to zero on the semantic differential scale. For example, the semantic differential portion of the questionnaire instrument asked respondents to rate the adoption of digital printing technology on a scale from negative three to three, with the negative three value associated with "Bad" and the positive three value associated with "Good." The mean value for respondents that did not intend to adopt digital printing technology was -0.25, indicating a relative indifference. The

Table 2: Direct Attitude Measure: Mean Values
Semantic Differential Scale –3.0 to 3.0

	Adoption Intention	
	No ($n = 13$)	Yes ($n = 8$)
Bad / Good	-.25	1.88
Disadvantageous / Advantageous	0.42	2.50
Harmful / Beneficial	0.25	2.25
Reckless / Well-Judged	0.08	2.43

mean value from intended adopters on the "Bad" to "Good" semantic differential resulted in 1.88, indicating a generally positive outlook about the technology adoption.

Turning to the Perceived Usefulness and Perceived Ease of Use constructs, respondents were asked to respond to a Likert-like question for the theorized factors which comprise the usefulness/ease of use constructs, as detailed in Tables 3 and 4. Overall, intended adopters believe that digital printing could be more easily integrated into their current work operations, and that adoption would enhance their business operations, whereas those that did not intend to adopt are more indifferent about the ease of use and usefulness dimensions.

In terms of *Perceived Ease of Use*, of particular note were the beliefs of the respondents about the amount of training required. Clearly those that did not intent to adopt reported that significant training would be required for digital printing, where responses from the intended adopters were more neutral, as illustrated in Table 3. Examining the *Perceived Usefulness* construct, intended adopters generally believed that capturing more business was an especially relevant factor, as such this differentiated them from their counterparts: this and the other components of the *Perceived Usefulness* construct are illustrated in Table 4.

Table 3: Perceived Usefulness — Mean Values
Likert-like scale: extremely unlikely (-3.0) to extremely likely (3.0)

	Adoption Intention	
	No ($n = 13$)	Yes ($n = 8$)
Integrating digital printing for labels would be easy for our company.	0.15	2.25
Adopting digital printing for labels would be frustrating for our employees.	0.15	-0.88
It would be easy for the employees in our company to become adept with digital printing technology.	0.77	1.88
Using digital printing would require significant training for our employees.	1.46	0.13
Digital printing for labels would make label production at our facility more difficult.	0.23	-2.00
Adopting digital printing for label production would disrupt our company.	0.08	-1.88
Overall, our company would find adopting digital printing for labels easy.	0.00	1.63

Findings

Due to the limited number of usable responses from the survey instrument, the results should be viewed as informational rather than of statistical inference. Nonetheless, several implications of note can be concluded from the data obtained here. First, although the label printing market segment seems to be a natural fit for production level digital printing technology, this view is not universal across all aspects of this segment. Some businesses simply do not view digital printing as viable for their particular operation at this time. This is reflected by the relative indifference in terms of *Attitude*, *Perceived Usefulness*, and

Table 4: Perceived Ease of Use - Mean Values
Likert-like scale: extremely unlikely (-3.0) to extremely likely (3.0)

	Adoption Intention	
	No ($n = 13$)	Yes ($n = 8$)
Utilizing digital printing for labels would give our company greater control over our work.	0.00	1.50
Digital printing for labels would improve productivity in our company..	0.00	2.13
Digital printing for labels supports critical aspects of the jobs of the employees of our company.	-0.58	1.13
Utilizing digital printing for labels would allow our company to accomplish critical tasks more quickly.	-0.17	1.75
Digital printing for labels would enhance our firm's effectiveness in the marketplace.	0.08	2.13
Adopting digital printing for labels would improve the quality of work produced by our company.	-0.67	1.13
The ability to offer digitally printed labels produced in-house would allow our company to capture more business.	0.33	2.50
Overall, the ability to produce labels that were digitally printed would be useful for our company.	0.17	2.50

Perceived Ease of Use in those label organizations that do not intend to adopt digital printing. In examining these constructs more closely, it is noteworthy to recognize that employee training and integration are viewed as a particularly significant obstacle separating those that do not intend to adopt from those that indicate an adoption intention. Further, the data revealed that differences noted between intended adopters and those that did not intend to adopt was most significant in terms of the perceived business case required to support adoption. In short, when it comes to capturing more customers, intended adopters clearly believe that digital printing technologies equate to more potential business, while this is less likely the case for their counterparts.

Conclusions

Using the structure of Davis' TAM to view potential adoption in this particular context shows promise as a manner in which to parsimoniously elicit salient factors germane to the adoption of innovation. *Attitude*, together with *Perceived Usefulness* and *Perceived Ease of Use* represent a framework where notable differences between intended adopters and those that do not intend to adopt a particular technology are reported, and offer implications for relevant stakeholders. For example, the realization that those label printers that do not intend to adopt digital printing technologies view employee training as an impediment could be significant to those that market such technologies. This could result in a focus on training, support, and a transition plan to help to assuage such concerns.

Based on the results of this survey, it is also important to recognize that the business case required for the adoption of new technologies is paramount. This realization has potential implications for not only vendors, but also educators as it suggests that for today's students to excel as tomorrow's business leaders they need to be well-versed in the business planning aspects of industry, whether their career is in the production or vendor sides of the business.

Future Research

Future researchers may choose to apply Davis' TAM to other research contexts: the *Perceived Ease of Use* and *Perceived Usefulness* constructs represent a succinct manner to gauge and measure potential adopters. It is likely that within domains where a more comprehensive sampling frame is available, larger response rates can be obtained that will allow enhanced statistical inferences to be drawn.

Furthermore, building on the cross-sectional, quantitative results here, future qualitative researchers can possibly reveal more in-depth knowledge of the nuances inherent in this particular innovation adoption context by using open-ended questions and case study methodologies.

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