ADOPTION OF LEARNING MANAGEMENT

SYSTEM TECHNOLOGY BY FIRE

SERVICE INSTRUCTORS

By

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"A society which is mobile, which is full of channels for the distribution of a change occurring anywhere, must see to it that its members are educated to personal initiative and adaptability. Otherwise, they will be overwhelmed by the changes in which they are caught and whose significance or connections they do not perceive. The result will be a confusion in which a few will appropriate to themselves the results of the blind and externally directed activities of others" (Dewey, 1916, p. 88).

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Title of Study: ADOPTION OF LEARNING MANAGEMENT SYSTEM TECHNOLOGY BY FIRE SERVICE INSTRUCTORS

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Abstract: This study explored the adoption of learning management system (LMS) technology by fire service instructors. The research identified what attributes of LMS technology lead to the adoption of the technology. This study used hypotheses and research questions related to diffusion of innovation theory (DoI) and the technology acceptance model (TAM) to develop a combined theoretical framework to identify those attributes.

The study combined the five perceived attributes of innovation constructs of DoI: relative advantage (RA), compatibility (CP), complexity (CPX), trialability (TR), and observability (OB) with the two main constructs of TAM: perceived usefulness (PU) and perceived ease of use (PEU).

This quantitative survey research collected responses from 357 fire service instructors from across the United States and utilized two types of statistical analysis to review the data. First, correlations were examined to explore the relationships between the attributes of the innovation and adoption; and, answer research questions for each construct's correlation to adoption. Second, structural equation modeling (SEM) was used to determine if the proposed combined theoretical model was appropriate for this population and supported the hypothesized relationships among the constructs.

While the attributes of innovations have been widely studied in other fields, there is very little research involving this population. This study advances an understanding of what innovation attributes lead fire service instructors to adopt and implement technology in their classrooms and training centers.

Findings indicated all of the constructs positively correlated to the intent to adopt and fire instructors prefer innovation attributes that are compatible with their way of working and that demonstrate advantages and usefulness over other options. SEM indicated that the proposed model was not appropriate and a new model with better fit was developed.

Keywords: adoption of innovations, firefighter training, SEM

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CHAPTER I

INTRODUCTION

For the past 80 years, research into the evolution and advancement of tools used in firefighting is well-documented (Childs, 2005; Donahue, Balaban, Cunnion, & Sochats, 2010; Holmgren, 2014a; Holmgren, 2014b; Kheel Center, 2017; Nja, 2011; Pinsky, 2013; Shay, 2010; Smith, Abrams, & Brakhage, 2015; Von Dehle, 2006; Wener, Panindre, Kumar, Feygina, Smith, Dalton, & Seal, 2015). What has not been widely explored is the adoption and use of educational technology available to the training programs that teach firefighters how to safely perform their jobs (Childs, 2005; Donahue, et al., 2010; Holmgren, 2014b). While the application of many new and innovative workforce training methods have been tested and researched in other fields, especially when it comes to using educational technology, fire service training instructors may be hesitant to embrace educational technology tools that could expand teaching strategies (Holmgren, 2014a, 2014b; Nja, 2011; Shay, 2010; Wener et al., 2015).

The majority of fire service trainers do not have the pedagogical expertise that formal training in instruction or adult education can provide (Holmgren, 2014a; Nja, 2011; Pinsky, 2013; Shay, 2010; Wener et al., 2015). Classroom management and preparation for courses that include innovative instructional strategies and current, relevant curriculum content requires time and effort to prepare. Some educational technologies are designed to make the management and delivery of learning materials easier so educators can give more time and attention to what they are teaching and how they are teaching it. One such technology, the learning management system (LMS), addresses many of the day-to-day tasks required for course management. LMS technology can help instructors improve and simplify their classroom management, decrease planning time, collaborate with students when not in the classroom, and provide students with learning materials they can access at their convenience. Some common features of LMS technology include discussion boards, grade books, and assessment and evaluation options (Bousbahi & Alrazgan, 2015; Burrough, 2015; Gautreau, 2011; Ruiz, Mintzer, & Leipzig, 2006). As a result, educators can dedicate time to exploring new ways to deliver curriculum to students using innovative instructional strategies. In an effort to make this technology accessible to instructors, many companies that develop and sell firefighter training materials offer free online LMS access for instructors using their products. These systems typically offer fire service trainers the tools they need to manage a course from beginning to end. This study was twofold. First, it explored the adoption and implementation of one type of educational technology, Learning Management Systems (LMS), by testing a previously developed theoretical framework based on the combination of diffusion of innovation theory (DoI) and the technology acceptance model (TAM) within the unique population of fire service instructors. The second goal of this study was to test whether or not the theoretical model was supported by this set of sample data using structural equation modeling.

Statement of the Problem

The occupational dangers firefighters face is very real. In the United States in 2015, 89 firefighters died while on duty – 36 from activities related to emergency incidents (U.S. Fire Administration, 2018). The intent of this statistic is not to suggest that the cause of these tragic losses is a result of the quantity or quality of training and education they received, but instead to point out that the overarching goal of education and training in this profession is to teach the best and most current life and safety practices available. The problem is that the life and safety training and education being provided to these public servants can be varied and inconsistent. Very few peer-reviewed, academic studies that directly address firefighter training were located. While the lack of research is, by itself, not a problem, the methodologies used to train life and safety job requirements for the occupation of firefighter could benefit from some sort of exploration. This extensive lack of research into the education and training of firefighters prevents instructors in fire service, who are typically subject matter experts (SMEs) and do not usually have education backgrounds, from advancing their craft. Studying fire instructor adoption rates of learning technologies like learning management systems could ignite a discourse about further study and advancement of firefighter training. While the use of learning technologies probably does not directly save lives, the availability of advanced technology options in education for those who train firefighters could possibly mitigate day-to-day classroom management tasks so that SME instructors have more time to dedicate to life and safety lessons. The information from this study could provide organizations that train firefighters with initial exploration into the attributes that influenced fire service instructors’ acceptance and adoption intentions with regards to education technology.

Theoretical and Conceptual Framework

This study was conducted within the theoretical framework of the Everett Rogers’ Diffusion of Innovations (DoI) Theory combined with Fred Davis’ Technology Acceptance Model (TAM). Research was readily available on the use of TAM and DoI independently (Agarwal, Sambamurthy, & Stair, 2000; Davis, Bagozzi, & Warshaw, 1989; Lee, Hsieh, & Hsu, 2011; Rogers, 2003; Venkatesh & Davis, 2000; Wu & Wang, 2005), however, there was some debate on whether either one alone offered enough information when it came to information technology (IT) adoption and implementation. The DoI framework has been applied in research since the 1940s to many types of innovations in education, marketing, communications, IT, and sociology (Agarwal, et al., 2000; Rogers, 2003; Ryan & Gross, 1943). The TAM portion of the framework has been applied to many technologies that require human-computer interaction since its inception in the 1980s (Davis, 1986; Davis, 1989; Davis et al., 1989; Marangunic & Granic, 2015; Walker, 2014). The two frameworks are similar in some ways and complement one another in others when it comes to IT studies. Combining the two provided a stronger model than either one on its own (Chen, Gillenson, & Sherrell, 2002; Lee et al., 2011; Wu & Wang, 2005). The researcher adopted the conceptual framework from previously conducted research (Lee at al., 2011; Wu & Wang 2005).

Diffusion of Innovation Theory (DoI)

DoI research has been applied to many disciplines like sociology, education, marketing, communications, agriculture, and IT since the 1940s (Agarwal, et al., 2000; Rogers, 2003; Ryan & Gross, 1943). An innovation is something – anything – that is perceived as new by an individual or “other unit of adoption”, such as an organization (Rogers, 2003). Diffusion is the “process by which an innovation is communicated through certain channels over time among members of a social system” (Rogers, 2003, p. 5). Therefore, DoI suggests that people “make decisions about whether or not to adopt or reject an innovation based on the beliefs they develop about the innovation” (Agarwal, 2000, p. 9). In this study, LMS technology was the innovation and individual fire instructors were the unit of adoption. This study asked fire instructors if the perceived attributes of LMS technology, including relative advantage, compatibility, complexity, trialability, and observability, influenced their decisions about whether or not to use the LMS technology available to them.

DoI is a theory that includes five different sets of variables (Figure 1) that are used to determine how:

1. the perceived attributes lead to adoption;
2. the type of decisions made about adoption;
3. the communication channels that facilitate adoption;
4. the impact of a change agent on adoption; and
5. a social system impacts adoption to determine the rate of adoption of innovations.

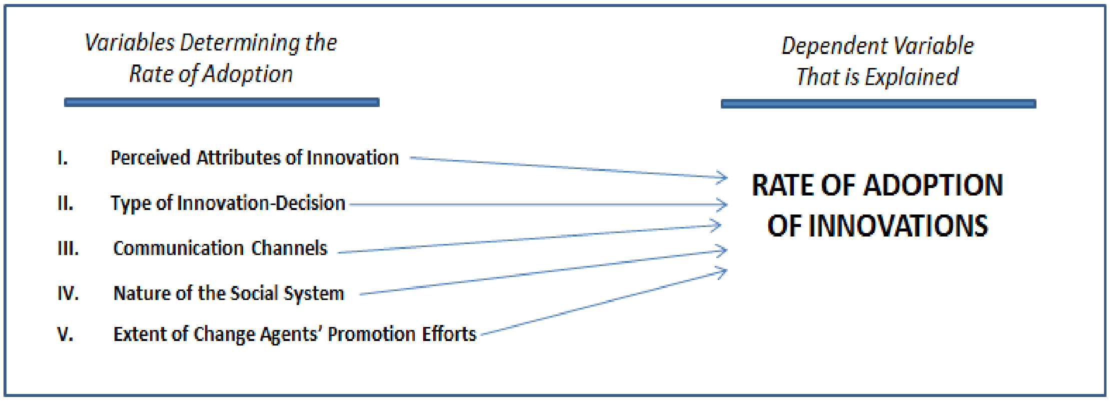


Figure 1. Modified Conceptual Framework of all Five Variable Sets Included in Diffusion of Innovation Theory. From *Diffusion of Innovations,* by E.M. Rogers, 2003. New York, N.Y.: The Free Press, a Division of Simon and Schuster. Copyright 2003 by Simon and Schuster. Reprinted with permission.

The variable sets have been used alone, in pairs, and as a whole in previous studies. The first variable set, the perceived attributes that lead to adoption, was the set used in this study. The five perceived attributes included in the variable set are relative advantage (RA), compatibility (CP), complexity (CPX), trialability (TR), and observability (OB) (Rogers, 2003). "The five perceived attributes of innovations have been most extensively investigated and have been found to explain about half of the variance in innovations' rates of adoption" (Rogers, 2003, p. 222). People make decisions about the adoption or rejection of an innovation after considering these five characteristics, and this variable set was the most applicable when studying the adoption decisions of technology users. Relative advantage is the level to which the potential adopter sees the new idea as better than the methods they already use. This is often the best predictor when it comes to adoption of an innovation (Rogers, 2003). Compatibility is the degree to which the innovation is regarded as being consistent with the users' existing knowledge, experience, and needs. Complexity refers to how difficult the user perceives the innovation to be to learn and use; trialability is how much testing and practice a user can get before they make a decision about adoption; and observability is the level to which the results of the use of the innovation can be seen by other people (Lee et al., 2011; Rogers, 2003). This particular set of variables was chosen because it concentrated the attention on the attributes of the innovation, in this case, LMS technology, instead of the differences in the people involved in the adoption or outside influences, like change agents and the social constructs in which they worked. The majority of diffusion research has concentrated on the differences in the people, which can be accomplished using the other variable sets in the theory. "Diffusion researchers in the past tended to regard all innovations as equivalent units from the viewpoint of their analysis. This oversimplification is dangerously incorrect" (Rogers, 2003, p. 219-220). This study was designed to avoid this oversimplification by concentrating on the attributes of the innovation itself and less on the people making the decisions to adopt.

Technology Acceptance Model (TAM)

The lack of adoption of new technology is a long-standing issue (Chen et al., 2002; Wu & Wang, 2005). The intent of the TAM is to be applicable to "any specific domain of human-computer interaction" (Lee et al., 2011, p. 125). TAM shows there are two end-user opinions that determine whether or not an end-user intends to adopt new technology: perceived usefulness (PU) and perceived ease of use (PEU). Perceived usefulness is the degree to which the user perceives the technology as useful in their job. The perceived ease of use is the degree of difficulty a user faces when using the technology (Davis et al., 1989). To get to these two end-user opinions, Davis looked to psychology. TAM was born from the theory of reasoned action (TRA) and, by extension, the theory of planned behavior (TPB) studied extensively by Martin Fishbein and Icek Ajzen.

DoI and TAM share some of the same ideas. The relative advantage of DoI is similar to PU in TAM and the complexity component of DoI can be compared to the PEU of TAM. They both also suggest that users' intent to adopt or use an innovation is at least partly determined by whether or not they find the innovation difficult to use or understand (Davis et al., 1989; Lee et al., 2011; Rogers, 2003). Compatibility is also a key component to both DoI and TAM. Users will compare the new technology to what they already use and what they already know, which ties in to the PU and PEU aspects of TAM. Basically, if a user can make a cognitive bridge between the old method and the new technology, they are more likely to adopt. Trialability and observability also compare to TAM in that the more exposure to the new innovation or technology people have the more useful and easier to use they will perceive it. There have been several studies that have successfully combined the two ideas of DoI and TAM (Chen et al., 2002; Chang & Tung, 2008; Hardgrave, Davis, & Riemenschneider, 2003; Lee et al., 2011; Wu & Wang, 2005). This study added to the discourse of combining the two theories and the education and training of firefighters (Figure 2) because this is a population that has not been explored previously.

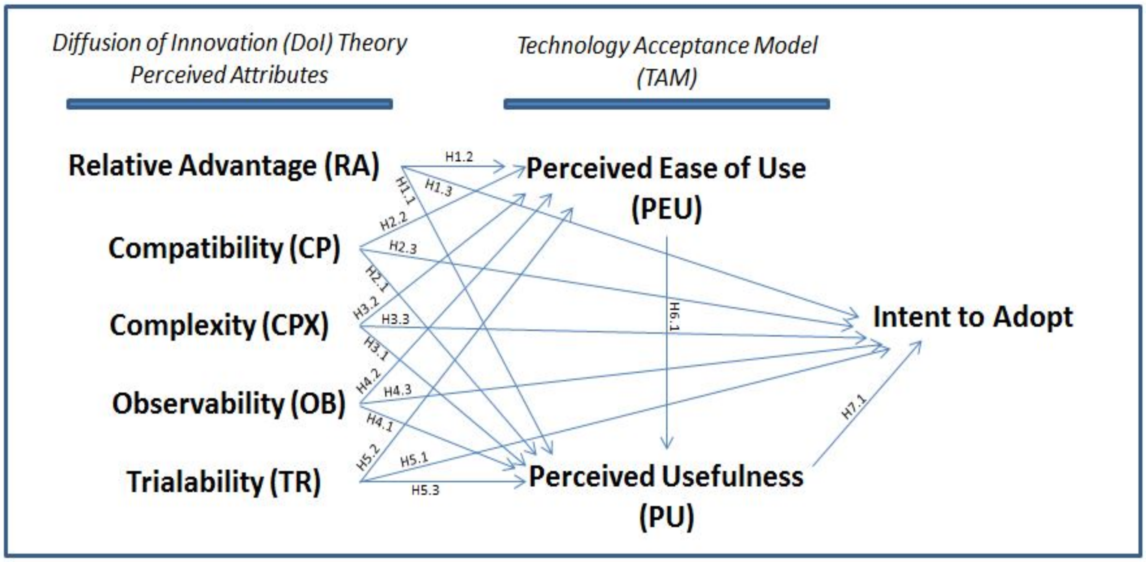


Figure 2. Conceptual Framework for Combining Diffusion of Innovation (DoI) Theory and the Technology Acceptance Model (TAM). Adapted from "Adding Innovation Diffusion Theory to the Technology Acceptance Model: Supporting Employees' Intentions to Use E-Learning Systems," by Y.-H. Lee, Y.-C. Hsieh, and C.-N. Hsu, 2011, *Educational Technology & Society, 14,* p. 129. Copyright © 2011 by Yi-Hsuan Lee, et al. Adapted with permission.

Theoretical Perspective and Epistemology

The theoretical perspective of this study was post-positivism. The information about the fire service instructor adoption behavior of LMS technology was readily available. As Sir Carl Popper suggested, this study engaged in "conjecture and falsification" by taking existing information from literature about hypotheses related to these theories and testing them with every effort to disprove them for this population of innovation adopters (Crotty, 1998). The objectivist epistemology informed this particular theoretical perspective that data gathered could offer insight into the link between technology characteristics and user adoption. This theoretical perspective and epistemological stance could influence other aspects of the research like the use of SEM.

Purpose of the Study

The purpose of this study was twofold. The first purpose was to explore the adoption and implementation of one type of educational technology, Learning Management Systems (LMS), by fire service instructors. LMS technology provides new and innovative ways to manage classrooms and provide instructional materials. Fire service instructors have access to several free LMS options, but did not readily adopt the technology. This study explored the adoption of LMS by fire service instructors using well-established hypotheses related to diffusion of innovation theory (DoI) and the technology acceptance model (TAM). The study combined the five perceived attributes of innovation variables of DoI: relative advantage (RA), compatibility (CP), complexity (CPX), trialability (TR), and observability (OB) with the two main constructs of TAM: perceived usefulness (PU) and perceived ease of use (PEU). It studied how these characteristics impacted LMS adoption intentions of fire service instructors. The second purpose of the study was to determine if the structural model proposed was a good fit for the data collected.

Research Questions and Hypotheses

The hypotheses and research questions for this study were adapted and modified from existing literature that applied to this study (Agarwal & Prasad, 1999; Hardgrave et al., 2003; Lee et al., 2011; Wu & Wang, 2005). Each of these hypothesis sets were addressed through multiple, specific questions on a survey instrument. For example, there were four questions that address the hypotheses included under relative advantage.

Relative Advantage

H1.1$_0$: The relative advantages of LMS technology do not affect the perceived usefulness of LMS technology.
H1.1$_1$: The relative advantages of LMS technology have a positive effect on perceived usefulness of LMS technology.

H1.1$_0$: $\mu = 0$
H1.1$_1$: $\mu \neq 0$

H1.2$_0$: The relative advantages of LMS technology do not affect the perceived ease of use of LMS technology.
H1.2$_1$: The relative advantages of LMS technology have a positive effect on perceived ease of use of LMS technology.

H1.2$_0$: $\mu = 0$
H1.2$_1$: $\mu \neq 0$

H1.3$_0$: The relative advantages of LMS technology do not affect the intent to adopt and use of LMS technology.
H1.3$_1$: The relative advantages of LMS technology have a positive effect on the intent to adopt and use of LMS technology.

H1.3$_0$: $\mu = 0$
H1.3$_1$: $\mu \neq 0$

RQ1: Is the relative advantage of LMS technology correlated with the intent to adopt LMS technology?

Compatibility

H2.1$_0$: Compatibility of LMS technology does not affect perceived usefulness of LMS technology.

H2.1$_1$: Compatibility of LMS technology has a positive effect on perceived usefulness of LMS technology.

$H2.1_0$: $\mu = 0$
$H2.1_1$: $\mu \neq 0$

$H2.2_0$: Compatibility of LMS technology does not affect perceived ease of use of LMS technology.

$H2.2_1$: Compatibility of LMS technology has a positive effect on perceived ease of use of LMS technology.

$H2.2_0$: $\mu = 0$
$H2.2_1$: $\mu \neq 0$

$H2.3_0$: Compatibility of LMS technology does not affect the intent to adopt and use of LMS technology.
$H2.3_1$: Compatibility of LMS technology has a positive effect on the intent to adopt and use of LMS technology.

$H2.3_0$: $\mu = 0$
$H2.3_1$: $\mu \neq 0$

RQ2: Is the compatibility of LMS technology correlated with the intent to adopt LMS technology?

Complexity

$H3.1_0$: Complexity of LMS technology does not affect perceived usefulness of LMS technology.

$H3.1_1$: Complexity of LMS technology negatively affects perceived usefulness of LMS technology.

$H3.1_0$: $\mu = 0$
$H3.1_1$: $\mu \neq 0$

$H3.2_0$: Complexity of LMS technology does not affect perceived ease of use of LMS technology.

$H3.2_1$: Complexity of LMS technology negatively affects perceived ease of use of LMS technology.

$H3.2_0$: $\mu = 0$
$H3.2_1$: $\mu \neq 0$

$H3.3_0$: Complexity of LMS technology does not affect the intent to adopt and use of LMS technology.

$H3.3_1$: Complexity of LMS technology negatively affects the intent to adopt and use of LMS technology.

$H3.3_0$: $\mu = 0$
$H3.3_1$: $\mu \neq 0$

RQ3: Is complexity of LMS technology correlated to the intent to adopt LMS technology?

Observability

$H4.1_0$: Observability of LMS technology does not affect perceived usefulness of LMS technology.

$H4.1_1$: Observability of LMS technology has a positive effect on perceived usefulness of LMS technology.

$H4.1_0$: $\mu = 0$
$H4.1_1$: $\mu \neq 0$

$H4.2_0$: Observability of LMS technology does not affect perceived ease of use of LMS technology.

$H4.2_1$: Observability of LMS technology has a positive effect on perceived ease of use of LMS technology.

$H4.2_0$: $\mu = 0$
$H4.2_1$: $\mu \neq 0$

$H4.3_0$: Observability of LMS technology does not affect the intent to adopt and use of LMS technology.
$H4.3_1$: Observability of LMS technology has a positive effect on the intent to adopt and use of LMS technology.

$H4.3_0$: $\mu = 0$
$H4.3_1$: $\mu \neq 0$

RQ4: Is observability of LMS technology correlated to the intent to adopt LMS technology?

Trialability

H5.1$_0$: Trialability of LMS technology does not affect perceived usefulness of LMS technology.
H5.1$_1$: Trialability of LMS technology has a positive effect on perceived usefulness of LMS technology.
H5.1$_0$: $\mu = 0$
H5.1$_1$: $\mu \neq 0$

H5.2$_0$: Trialability of LMS technology does not affect perceived ease of use of LMS technology.

H5.2$_1$: Trialability of LMS technology has a positive effect on perceived ease of use of LMS technology.

H5.2$_0$: $\mu = 0$
H5.2$_1$: $\mu \neq 0$

H5.3$_0$: Trialability of LMS technology does not affect the intent to adopt and use learning management systems.
H5.3$_1$: Trialability of LMS technology has a positive effect on the intent to adopt and use learning management systems.

H5.3$_0$: $\mu = 0$
H5.3$_1$: $\mu \neq 0$

RQ5: Is trialability of LMS technology correlated to the intent to adopt LMS technology?

Perceived Ease of Use

H6.1$_0$: Perceived ease of use of LMS technology has no effect on the perceived usefulness of learning management systems.

H6.1$_1$: Perceived ease of use of LMS technology has a positive effect on the perceived usefulness of learning management systems.

H6.1$_0$: $\mu = 0$
H6.1$_1$: $\mu \neq 0$

RQ6: Is perceived ease of use of LMS technology correlated the perceived usefulness of LMS technology?

Perceived Usefulness

$H7.1_0$: Perceived usefulness of LMS technology has no effect on the intention to adopt and use learning management systems.

$H7.1_1$: Perceived usefulness of LMS technology has a positive effect on the intention to adopt and use learning management systems.

$H7.1_0$: $\mu = 0$
$H7.1_1$: $\mu \neq 0$

RQ7: Is perceived usefulness of LMS technology correlated with the intent to adopt LMS technology?

$H7.1_0$: $\rho = 0$
$H7.1_1$: $\rho \neq 0$

RQ8: Does the proposed research model align with theoretical hypotheses as they apply to fire service instructors?

Significance of the Study

This research contributed to the long history of DoI and showed how it could be applied in yet another context. It also contributed to the knowledge about TAM by applying it to an additional population, fire service instructors, about a specific type of technology, learning management systems. It was important to the integration of DoI and TAM, as combining the two existing theoretical frames makes them individually stronger (Lee et al., 2011; Wu & Wang 2005). The study additionally contributed to the use of SEM as a research technique for DoI and TAM studies, as well as for this population. The most important contribution was information about technology adoption attitudes and intentions for organizations that regularly use subject matter experts (SMEs) as instructors. There are many areas in which SME-as-instructors is a common practice including many vocational-technical programs, pipeline inspection, nursing, policing, and firefighting. It provided organizations that offer educational technology options to fire service instructors some insight into the adoption attitudes that exist among fire service instructors when it came to new learning technologies that could positively impact training goals. As is traditional with post-positivist studies, the aim of this study was to explain, predict, and perhaps even control behavior. The knowledge gained in this study could inform the control and prediction of adoption rates for future educational technologies in this and similar professions.

Assumptions and Limitations of this Study

The research assumed all participants had an adequate understanding of all questions included in the survey, and all participants answered questions honestly. This study was limited in that the sample is fire service instructors with access to learning management systems. Such limitation will impact generalizability, and findings can only be generalized to individuals who instruct in fire service organizations who have access to learning management systems. This was additionally impacted by the lack of information on the actual population of fire service instructors.

Other limitations came from DoI, TAM and SEM. For DoI, there are several limitations to the theory that have persisted over time. The first is what Rogers called the "recall problem" (Rogers, 2003, p. 126). Because innovations diffuse over time, it is sometimes difficult for people who adopted in the past to recall their motivations at the time of adoption. "Essentially, people are asked to look back in time in order to reconstruct their past history of innovation experiences" (Rogers, 2003, p. 127). Some of the reasons for this are the same types of attitudes that lead people to adopt in the first place, including whether or not the technology is important to them. Others are the simple passage of time, especially for those who have had access to the technology for a long time, but have not adopted. Then there are the differences in people, such as memory characteristics and capabilities. Another limit of this study was determining the “why” questions that come up as a result of answers to Likert-type responses. The intent of this study was to open the discourse on this topic and these first responses will provide the groundwork for further study. A criticism of both DoI and TAM is what Rogers referred to as “pro-innovation bias,” which points out that the mere questioning of the reasons for adopting an innovation suggests that not adopting is somehow the wrong decision (Rogers, 2003). This leads into another limitation to the research which is that it sometimes gives the appearance that the researcher is siding with the companies that are pushing the innovation (Rogers, 2003). While the researcher was once employed by a company that produced firefighter curriculum and provided a free LMS service, the researcher had no personal or professional benefits tied to the outcome of responses to this study. SEM also offers assumptions and limitations. One of the most important is the risk of attributing causality to the results of SEM analysis. “The ability of SEM to produce meaningful identification of the correlations between factors is a key strength” (Hox & Bechger, 2007, p. 5), however, correlation is not the same as causality, so researchers using this method have to be cautious. Another possible limitation is that SEM is a large sample method and what defines a “large” sample is not clearly defined in research.

Table 1

Conceptual and Operational Definitions

Topic	Conceptual Definition	Operational Definition
Educational Technology	Involves the disciplined application of knowledge for the purpose of improving learning, instruction, and/or performance (Spector, 2012)	Technology that assists instructors in classroom and materials management
Learning Management System (LMS)	Software applications "used to deliver online material and training programs to students while tracking their progress and generating reports" (Bousbahi & Alrazgan, 2015)	Internet-based software that provides fire service instructors a standard location to provide students with class materials, organize their course administration, and track student progress
Diffusion of Innovation (DoI)	A theory developed by Everett M. Rogers that says diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 2003)	The theory as applied to the diffusion of learning management systems by fire service instructors
Innovation	"An idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p. 12)	Learning management system technology
Compatibility (CP)	"The degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters" (Rogers, 2003, p. 240)	The degree to which the LMS will provide needed assistance to fire service instructors
Relative Advantage (RA)	"The degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers, 2003, p. 229)	The degree to which learning management systems are better than the current method of classroom or materials management or lack thereof
Complexity (CPX)	"The degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers, 2003, p. 257)	How difficult the LMS technology is perceived to understand or use
Observability (OB)	"The degree to which the results of an innovation are visible to others" (Rogers, 2003, p. 258)	The degree to which fire service instructors can see others using LMS technology successfully
Trialability (TR)	"The degree to which an innovation may be experimented with on a limited basis" (Rogers, 2003, p. 258)	The degree to which fire service instructors can experiment with the LMS technology

Homophily	“The degree to which a pair of individuals who communicate are similar” (Rogers, 2003, p. 305)	The degree to which people who are communicating share the same norms, opinions, and common meanings and understandings
Heterophily	“The degree to which pair of individuals who interact are different in certain attributes” (Rogers, 2003, p. 306)	The degree to which people who are communicating are different from one another in norms, opinions, and common meanings and understandings
Change Agent	“An individual who influences clients’ innovation-decisions in a direction deemed desirable by a change agency” (Rogers, 2003, p. 366)	Marketing representatives, farm extension officers, promoters, or anyone who is advocating for the adoption of an innovation
Technology Acceptance Model (TAM)	A research model developed by Fred Davis in 1986 that “presumes a mediating role of two variables called perceived ease of use and perceived usefulness” in the relationship between a system’s characteristics and a user’s intent to use the system (Marangunuc & Granic, 2015, p. 81)	This model’s variables, PEU and PU, combined with the system characteristics specified by DoI will be used to determine user intent of learning management systems among fire service instructors
Perceived ease of use (PEU)	“The degree to which the prospective user expects the target system to be free of effort” (Davis et al., 1989, p. 985)	The degree to which fire service instructors expect LMS to be easy to use
Perceived usefulness (PU)	“The prospective user’s subjective probability that using a specific application system will increase his or her job performance within an organizational context” (Davis et al., 1989, p. 985)	Fire instructors’ perceptions that LMS technology will make their jobs easier
Career firefighter	“Person whose primary employment is as firefighter within a fire department” (Smith et al., 2015, p. 385)	Firefighters whose main job is working as a firefighter in a municipal or district fire department
Volunteer firefighter	“Active member of a fire department who may receive monetary compensation for on-call time and/or firefighting duty time” (Smith et al., 2015, p. 574)	Men and women who dedicate their spare time to the training and duties required to provide services to their community with or without monetary compensation
Authority Having Jurisdiction (AHJ)	“An organization, office, or individual responsible for enforcing the requirements of a code or standard, or approving equipment, materials, an installation, or a	A city council, fire district board, etc., that governs the locale’s fire services

	procedure" (Smith et al., 2015, p. 369)	
Standard	"A set of principles, protocols, or procedures that explain how to do something or provide a set of minimum standards to be followed. Adhering to a standard is not required by law, although standards may be incorporated in codes, which are legally enforceable" (Smith et al., 2015, p. 549)	NFPA standards
Code	"A collection of rules and regulations that has been enacted by law in a particular jurisdiction. Codes typically address a single subject area; examples include a mechanical, electrical, building, or fire code" (Smith et al., 2015, p. 393)	A standard that has been adopted by an AHJ, which makes it legally binding
Job Performance Requirements (JPRs)	"Statement that describes a specific job task, lists the items necessary to complete the task, and defines measurable or observable outcomes and evaluation areas for the specific task" (Smith, et al., 2015, p. 472)	Knowledge-based or performance-based tasks required to meet certification standards

Summary

There was very little research into the field of fire serve training and many fire service trainers do not have formal training about instruction or adult education. These two issues combined to provide an area ripe for research. This study utilized long-established research hypotheses in DoI and TAM to research the adoption of LMS technology by fire service instructors. In addition to this exploration, the study used SEM to analyze the hypotheses to determine if the proposed research model aligned with theoretical hypotheses as they applied to fire service instructors.

CHAPTER II

LITERATURE REVIEW

In a 1963 speech in Frankfort, Germany, President John F. Kennedy said: “Change is the law of life. And those who look only to the past or present are certain to miss the future” (JFK Presidential Library and Museum, n.d.). This is especially applicable when applied to technological advances that can improve day-to-day tasks. The purpose of this study was to explore the adoption of a specific type of educational technology, Learning Management Systems (LMS), in fire service training and determine if the proposed research model aligned with theoretical hypotheses as they applied to fire service instructors. Literature on the topic of the pedagogical tools and methods used in fire service training was seriously lacking (Childs, 2005; Donahue et al., 2010; Holmgren, 2014a, 2014b; Shay, 2010; Wener et al., 2015). Extensive searches for literature on the topic produced only a few published, academic, and peer-reviewed studies that directly addressed firefighter training methodology (Childs, 2002; Holmgren, 2014a, 2014b; Nja, 2011; Wener et al., 2015). Literature for this review was located using several databases and search tools including, EBSCO, ProQuest, JSTOR, Google Scholar, ERIC, Academic Search Premier and other tools available through the Edmon Low Library at Oklahoma State University. Keywords used for the searches included: diffusion of innovation, technology acceptance model, TAM, firefighter training, firefighter education, learning management system adoption, blended learning in firefighting, structural equation modeling, SEM, and many others. The researcher also used websites linked to professional memberships including the Association of Training and Development (ATD) and eLearning Guild for information about LMS technology and adult learning. Attempts were made to narrow the literature to the past ten years, but because of the long history associated with some of the topics and the lack of recent studies, older literature was also included. This review not only helped identify the lack of available information on the current topic of study, but it also revealed that many writers in academia and the fire service have been calling for an increase in research into fire training pedagogy and methodology since at least 2002 (Childs, 2002; Donahue et al., 2010, Finger, 2016; Holmgren, 2014a, 2014b; Nja, 2011; Pinsky, 2013; Shay, 2010; Wener et al., 2015). The difficulty for this type of research could be because the topic of fire service instruction lies at the intersection of education and fire service. Because the very basic goal of fire training is ensuring the lives and safety of firefighters, the research into fire service training spreads out into many topic-restricted silos rather than being researched as a discipline in and of itself. For example, Childs (2002, 2005) concentrated on the "professionalization" of the firefighter occupation itself and the training required to meet that standard, while Holmgren (2014a; 2014b) focused on distance learning in firefighting training in Sweden and Nja (2011) researched gaming methodology in firefighter training in Norway. This lack of cohesion in the literature reflected the very nature of fire service training itself, as Donahue, et al. (2010) pointed out.

This literature review focused on the history and current status of firefighter education practices, an explanation of LMS technology and the adoption of the technology by instructors in other fields, theoretical considerations of diffusion of innovation theory and the technology acceptance model individually and together, and the use of SEM as a research method.

Fire Service Training

To understand the current status of fire service training, it is important to briefly review some fire service history, the demographics of firefighters in the U.S., and how the fire service is organized and governed.

Fire service came to the U.S. via Europe with the first immigrants. Jamestown, the first settlement in Virginia of immigrants from Europe, almost completely burned to the ground. As a result, the settlements that followed developed building codes and appointed fire wardens who patrolled the community watching for fire and sounding the alarm if needed (Clausing & Snyder, 2012; Smith et al., 2015). The first paid fire department in the U.S. was established in Boston in 1679 and Benjamin Franklin started the first volunteer fire department in Philadelphia in 1735. These two types of departments continue to dominate the firefighting landscape in the U.S. According to a 2014 report from the National Fire Protection Association (NFPA), there were 1,134,400 firefighters in the U.S. in 2014. Of those, 69% were volunteers (Figure 3).

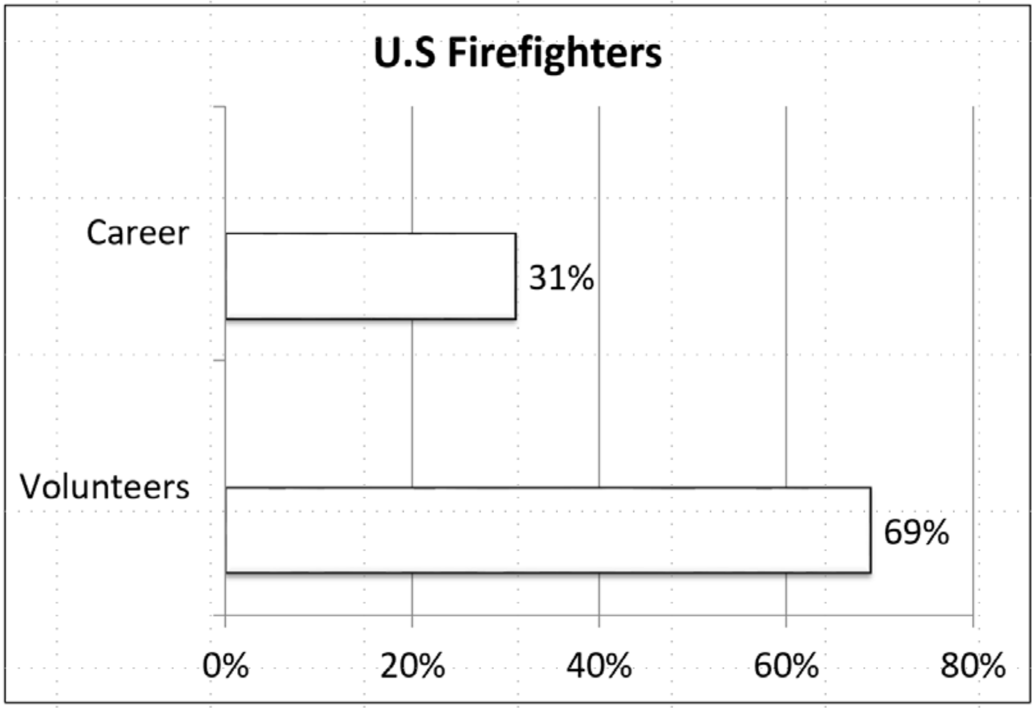


Figure 3. Graph Depicting the Distinct Difference in the Number of Volunteer Firefighters and Career Firefighters in the U.S.

Of the 27,198 fire departments registered with the U.S. Fire Administration in January 2016, the percentage of volunteer departments was 71% (Haynes & Stein, 2016). Fire departments are additionally divided into four categories: all career, mostly career, mostly volunteer, and all volunteer. While municipalities are the most common jurisdiction for fire departments, the organization of fire services for a location is determined by the citizens in the service area. The size of the area to be covered, the population, and the fire risk factors in the coverage area are all used to determine the type of department needed. Operating a fire department, regardless of the type, is an expensive endeavor. Establishing a department requires administration, personnel, equipment, maintenance, and training. It is not unusual to see county-wide departments and fire protection districts that cover several local jurisdictions that enable the communities to share the fiscal responsibility (Smith et al., 2015). This variation in types of firefighters and the departments in which they can work or serve could add to the training research difficulties.

Many of the developments and advances in fire service technology, building codes, fire safety, and prevention which result in vast training needs in fire service have been in response to tragic historical fire events. For example, on March 25, 1911, 146 workers, mostly young immigrant women, were killed when the garment factory in which they worked in New York City caught fire. While the deplorable working conditions in the factory contributed to the fire, the absence of safety measures like reliable means of egress and fire suppression were also cited as contributing factors to the loss of life. This tragedy led to not only new labor requirements, but also building requirements like sprinkler systems in high-rise buildings and outward-swinging exit doors (Kheel Center, 2017; Von Dehle, 2006). These new practices were first adopted in New York City and then spread across the country. These innovations, sprinklers and outward-swinging doors, were eventually codified and incorporated into the standards that govern firefighting. Tragic loss of civilian lives and property are not the only events that have resulted in new life and safety requirements. There have also been many fire events that have resulted in the loss of firefighters. In 2013, 19 firefighters were killed during their response to a wildfire in Arizona and 343 firefighters died during the response to the September 11, 2001, attacks on the World Trade Center. It is worth noting that there appeared to be a surge in emergency services research following the September 11, 2001, attacks. Again, it was not specific to firefighters, but to all emergency responders like paramedics and police. All of these events, past and present, typically inform new practices and protocols to prevent and mitigate future events. Rolling out new practices and protocols requires training for the new innovations.

Fire service training in the U.S. is primarily based on life and safety standards devised by the National Fire Protection Association® (NFPA®). NFPA® standards have been developed by committees of subject matter experts (SMEs) since the 1970s. It is important to note they are standards, defined in Smith et al. (2015), in part, as follows:

> A set of principles, protocols, or procedures that explain how to do something or provide a set of minimum standards to be followed. Adhering to a standard is not required by law, although standards may be incorporated in codes, which are legally enforceable. (p. 549)

As defined above, following a standard is not required. Codes, on the other hand, are legally enforceable. To make a NFPA® standard a legally-binding code, the standard must be adopted by an Authority Having Jurisdiction (AHJ) over a fire department or district. For example, if a municipality wants to adopt a particular NFPA® standard for their jurisdiction, like building code, the city council is the AHJ that must adopt the standard. Standards address broad topics like NFPA 101: Life Safety Code ®, which provides information about reducing the threat of fire to people in structures, or a variety of more specific topics like automatic sprinkler systems, fire alarms, and fire extinguishers. Most significantly the NFPA® writes the professional qualification standards for firefighters. The standards detail exactly what knowledge-based items firefighters are expected to know as well as the tasks they are expected to perform on the job. These are called Job Performance Requirements (JPRs). While the goal of the standard is to ensure all firefighters learn the same information, the standard is where any commonality in training ends. While the subject matter students are required to learn is laid out in detail, there are no set requirements about curriculum development, how the training should be managed or delivered, or how long it should take to teach or to learn the information. As with the various types of fire departments, there are also a variety of training options available. These include local fire department training divisions; state, regional or national academies; vocational-technical schools; community colleges; universities; professional organizations; and private training academies (Clausing & Snyder 2012; Smith et al., 2015). Each one can approach training in a completely different way. Even the eventual certification of the firefighter candidates is not limited to one option. There are two certification organizations from which learners can seek certification: Pro Board ® Fire Service Professional Qualifications and the International Fire Service Accreditation Congress. This lack of cohesion in fire service training has been noted for many years in a number of peer-reviewed journal articles, professional journals, and reports on the current state of affairs in training and education in fire service (Baigent et al., 2003; Donahue et al., 2010; Kobziar et al., 2009).

This variety of approaches in the organization of the training environment bleeds over to the instructors as well. NFPA 1041: Standard for Fire Service Instructor Professional Qualification (2012) sets the minimum knowledge and performance requirements for fire service instructors. Like the training for firefighters, this instructor training can be approached in whatever manner any of the above-listed organizations that offer the training chooses or not at all. AHJ edicts determine the instructor standards for the departments under their purview. All of the other types of education providers have their own requirements for instructors as well. On top of that, no organization is required to adopt the NFPA® fire instructor standards. Currently, there are three levels of instructor certification available, progressing from the basic delivery of prepared curriculum to the development of curriculum, and eventually supervision of training programs or staff. The courses that can result in any one level of instructor certification are sometimes taught in less than a week. It is not unusual for a course to include lecture and practice Monday through Thursday with the certification test on Friday. The standards for fire service instructors include JPRs like:

- Training program management
- Record-keeping
- Reports
- Assembling course materials
- Scheduling classes
- Reviewing course materials
- Recognizing the target audience and learning environment
- Organizing resources for the course
- Cultural diversity
- Student limitations
- Preparation and organization skills
- Delivery of classes utilizing prepared curriculum
- Classroom organization and management
- Outdoor laboratory organization and management

- Audiovisual equipment
- Teaching aids
- Safety
- Principles of learning
- Instruction techniques
- Communication techniques
- Training hazards
- Distance learning
- Adjusting for changing circumstances
- Learning styles
- Student motivation
- Learning disabilities
- Disruptive behaviors
- Adaptation of learning materials
- Maintenance of audiovisual and field equipment
- Administration and grading of written, oral, and performance evaluations
- Grading methods
- Elimination of grading bias
- Confidentiality
- Interpretation of test grades
- How to provide positive, motivational feedback

This represents only a partial JPR list for only Instructor 1 certification. Professional educators spend entire careers learning, improving, and nurturing these and many more skills. Even if a fire instructor completes all three levels, the training time cannot begin to prepare a person to actually deliver and manage a course effectively. Even more importantly, AHJs are not required to adopt the instructor standard. Certification as a fire service instructor is not a prerequisite for training in many cases. As a result, in organizations outside of the larger career fire departments, fire service training organizations and/or academies, or colleges and universities, it is more likely instructors will be individual firefighters without instructor certification or any other type of education training who get assigned to teach (Finger, 2016; Holmgren 2014a; Pinsky 2013; Shay, 2010). This "SME-as-instructor" practice is not unique to fire service. This practice is very common in vocational-technical schools, policing, pipeline inspection, and medical education (Burrough, 2015). Holmgren (2014a, 2014b) calls this type of training as "ego-centric" in firefighter training and has led to instructor resistance to distance learning technology as an option in Sweden.

This overall lack of cohesion could arguably be attributed to the minimum amount of academic research into the training and education of firefighters. Four years of exploring available literature produced few peer-reviewed, academic journal articles or research on the topic (Childs, 2002; Holmgren, 2014a, 2014b; Nja, 2011). Several other articles found in peer-reviewed professional publications, mostly based on opinions of people in fire service, were readily available and calling for change and advancement in training in fire service (Finger, 2016; Pinky, 2013; Shay, 2010; Kazmierzak, 2016). In this variety of literature offerings one common theme emerged: reluctance or resistance to change. Holmgren (2014a) argued that the availability of technology in education requires instructors to "review their own role and their thinking about teaching, as well as acquire new ways to interact and communicate content to students" (Holmgren, 2014a, p. 2). Firefighter training is very instructor-centered and anchored in the banking method of education where students are vessels receiving knowledge from the instructor, who is the main source of information (Freire, 2000). This is typically accomplished through long periods of PowerPoint presentations and lecture and then hands-on skills training, still under the strict direction of the instructor. This "sage on the stage" approach to instruction and classroom management is firmly entrenched in fire service (Childs, 2005; Holmgren, 2014a, 2014b; Finger, 2016; Shay, 2010; Wener et al., 2015). This reluctance or resistance to change is common in many aspects of fire service; it is not exclusive to training methods, technologies, and strategies. Other areas of fire service research noted that the reluctance to change extends to several aspects of fire service technologies and practices. For example, Butler and Goldstein (2010) wrote about Gunderson and Holling's 2002 "rigidity trap" as it applied to wildland fire management in the U.S. Gunderson and Holling (2002) define a rigidity trap as pathological resistance to novelty and innovation. Butler and Goldstein used this to explain the reluctance of many agencies to adopt new policy and practices that encouraged ecological fire restoration in the face of massive wild fires. Many agencies continued to focus on suppression when it came to planning and management and ignored the new innovations. This resistance to technology adoption was also not exclusive to firefighter training, it was very common in medical educators (Burrough, 2015; Myers, 2010; Phillips & Vinten, 2010; Ruiz et al., 2006), university faculty (Coskuncay & Ozkan, 2013; Gautreau, 2011; Joseph, 2008), and government employees as well (Lee et al., 2011).

Variety may be the spice of life, but when it comes to preparing individuals to risk their lives to save others, a little less variety might be a better practice. This unique intersection of education and fire service could benefit from research as its own discipline instead of just another silo in fire service topics.

Learning Management Systems

In this study, learning management system (LMS) technology was the innovation for which adoption behaviors were sought. A review of the literature into LMS revealed comprehensive lists of advantages of LMS technology for instructors in several fields (Bousbahi & Alrazgan, 2015; Burrough, 2015; Gautreau, 2011; Ruiz et al., 2006), an interesting history review of this technology's place in the world of educational technology as a whole (Aslan & Reigeluth, 2011; Burrough, 2015; Ruiz et al., 2006), as well as many research studies into the adoption of LMS in a variety of different educational settings from workforce training to higher education (Bousbahi & Alrazgan, 2015; Findik & Ozkan, 2013; Gautreau, 2011; Walker, 2014).

Learning management system (LMS) technology includes software applications "used to deliver online material and training programs to students while tracking their progress and generating reports" (Bousbahi & Alrazgan, 2015, p. 1). LMS technology can help instructors improve and simplify their classroom management, decrease planning time, collaborate with students when not in the classroom, and provide students with learning materials they can access at their convenience. Some common features of LMS technology include discussion boards, grade books, and assessment and evaluation options. Specific advantages of LMS technology pointed out by researchers include:

- an online repository and organization format for course materials,
- texts,
- multimedia elements,
- communication tools that enable instructors to engage with students outside of the classroom, and
- evaluation options that go beyond just online testing and grading (Bousbahi & Alrazgan, 2015; Gautreau, 2011; Ruiz et al., 2006)

LMS technology allows instructors to post tutorials and remediation materials for learners that can be assigned and accessed individually by students. It also allows instructors to monitor student activity regarding the materials provided. For example, if a student performs poorly on an assessment, an instructor could access information that tells them whether or not a student has accessed assigned study materials and how much time they have spent online within the course.

To understand how LMS technology was developed, a brief history of educational technology is required. Saettler (2004) lays out a very comprehensive history of educational technology as a whole in his book, which starts in 450 B.C. and continues all the way through the 1990s. Aslan and Reigeluth (2011) provide a more specific history of computers as tools in education by grouping the different stages of technology use in education into three stages which are summarized in Table 2.

Table 2

Historical Stages of Technology Use in the Classroom

Time Period	Description	Examples of Technology
Mainframe Period (Late 1950s to 1970s)	This period featured computers used as single topic tutors. There were many attempts to make this technology available in conventional education settings, but it mainly flourished in military training applications	Computer-assisted instruction tools: SOCRATES (System for Organizing Content to Review and Teach Educational Subjects CLASS (Computer-based Laboratory for Automation of School Systems) PLATO: featured a network between an instructor computer and individual computers for students in a single classroom
Microcomputer Period (Late 1970s to the End of the 1990s)	This period featured the explosion of access to personal computers. Computers in the classroom were still focused on tutorial use until the early 1990s when word processing, spreadsheet, and drawing applications became popular (Aslan & Reigeluth, 2011; Saettler, 2004).	Kit-form microcomputers, networking capabilities, mouse technology, advanced graphics, and word processing and spreadsheet software (Aslan & Reigeluth, 2011; Saettler, 2004).
Internet Period (Early 2000s - 2011)	This period saw the explosion of access to the Internet and changed the way computers were used in the classroom. It also saw a change in the learning environment from behaviorist- to constructivist-inspired learning activities. This is also the period that saw the development of LMS technology and data management systems (Aslan & Reigeluth, 2011)	Internet connections provided teachers with: Websites as secondary sources Multiple-choice quiz systems Internet-based activities Laptop computers Wireless technology Handheld devices Collaborative tools Social networks Data management options Learning Management Systems (LMS) (Aslan & Reigeluth, 2011)

Despite the advantages of LMS technology and the growing use of the technology in the past 20 years, LMS cannot escape the problem that many new information technology developments have suffered: user adoption (Surry, 1997). Gautreau (2011) stated LMS technology and delivery capabilities required instructors and teachers to think differently about teaching that often required new skills and knowledge. This was no different than the reluctance to change among fire service instructors. Reluctance to adopt LMS technology has led to many studies on the adoption of LMS technology in many educational settings with different types of faculty or instructors (Bousbahi & Alrazgan, 2015; Burrough, 2015; Coskuncay & Ozkan, 2013; Gautreau, 2011; Joseph 2008; Ruiz et al., 2006; Walker, 2014). Fire instructor adoption of LMS technology had not been studied.

Diffusion of Innovations Theory

Enter "diffusion of innovations" in the search engine at Edmon Low Library at Oklahoma State University and the result will return 133,595 items. Of those, 71,420 are in peer-reviewed journals. Search Google for "diffusion of innovation theory" and, in less than .53 seconds, 12,500,000 results will appear. According to Rogers, Singhal, & Quinlan (2009), Rogers' book, *Diffusion of Innovations* was the "second most cited book in the social sciences" (Rogers et al., 2009, p. 418). Dearing also agreed in 2009: "Few social science theories have a history of conceptual and empirical study as long as does the diffusion of innovation" (p. 510). The widespread use of this theory in a number of disciplines and fields of study for over 60 years are what make diffusion of innovation theory (DoI) such a robust topic (Burrough, 2015; Chen, 2002; Dearing, 2009; Doyle, Garrett, & Currie, 2014; Fasteen, 2016; Gouws & van Reede von Oudtshoorn, 2011; Hsu, 2016; Lee et al., 2011; MacVaugh & Schiavone, 2010; Miller & Bull, 2013; Moore & Benbasat, 1991; Reggi, Arduini, Biagetti, & Zanfei, 2014; Rogers, 2003; Rogers et al., 2009; Ryan & Gross, 1943; Singhal, 2012; Surry, 1997; Ward, 2013).

Gabriel Tarde, a French judge, first wrote about diffusion in his 1902 book, *The Laws of Imitation,* after noticing the way people adopted new words and manner of dress in a predictable fashion. According to Rogers (2003), Tarde wanted to know why, when hundreds of new ideas were available, only a few were widely adopted. He observed that the rate of adoption of a new idea, or innovation, typically followed an S-shaped curve over time, a conclusion that has remained a foundation of diffusion studies that measure adoption over time. In Germany at about the same time, Georg Simmel was also writing about diffusion and how individuals are influenced by their social networks in his book *Conflict: The Web of Group Affiliations*. The concept of social system influence also remains a variable in current diffusion theory for those who study this influence on innovation adoption. From these separate, but similar sociological beginnings, anthropologists in Britain and other areas of Europe adopted a "diffusionist" view that all social change could be explained by diffusion alone (Rogers, 2003). This extreme view did not serve them well, but it did bring the term "diffusion" and the ideas behind it to the attention of other scholars. Anthropologists are credited with having "the oldest of the diffusion research traditions" (Rogers, 2003, p. 43). While diffusion research continued in small pockets of academia for many years, it was the hybrid seed corn study by Bryce Ryan and Neil Gross in 1943 that set the stage for a paradigm shift in diffusion theory and provided a research framework that shaped the theory as it is known today. The study not only supported the S-shaped curve first suggested by Tarde and specifically studied the communications that most influenced the adoption of the hybrid seed corn as suggested by Simmel, but more importantly, it set forth a research methodology that set the stage for modern diffusion research (Rogers, 2003; Ryan & Gross, 1943).

Ryan and Gross' research began when they discovered that Iowa farmers were not adopting hybrid seed corn that would increase their farm yields by 20%, stand up to drought, and produce sturdier stalks that could stand up to mechanical harvesting. They wanted to know why, if this innovation could make their farms more successful, the farmers were not using the seed corn. Ryan sought and received funding to study the phenomenon in two neighboring Iowa farming communities. Through interviews and surveys they were able to identify variables that impacted the adoption of the hybrid seed corn and published what would become the basis of the research methodology for DoI Theory (Dearing, 2009; Rogers, 2003; Rogers et al., 2009; Ryan & Gross, 1943). Their research found: the rate of adoption of an innovation will form an S-shaped curve over time; categories of adopters based on when they adopted the innovation (but did not name those categories); how an adopter's individual innovativeness impacted their decisions; and, more importantly, how the opinions of other farmers in their peer groups influenced adoption decisions. "At the heart of the diffusion process was information-exchange about the innovation, as farmers shared their personal and subjective experiences with the new idea, gradually giving meaning to the innovation" (Rogers, 2003, p. 15). After the 1943 study, diffusion research went dormant for nearly a decade. In 1954, it picked up again in Iowa when Everett Rogers, who spent 47 years studying, implementing, and writing about diffusion theory, entered the field of diffusion research as a graduate student. His doctoral dissertation, "A Conceptual Variable Analysis of Technological

Change”, studied the adoption of agricultural innovations in a rural Iowa town. The literature chapter of that work eventually became the book *Diffusion of Innovations* which launched Rogers onto the world stage and provided a template for not only studying the diffusion of single innovations in a population, but also a way to influence and drive social change (Singhal, 2012). “In the 1960s, national governments of newly independent countries of Asia, Africa, and Latin America were wrestling with how to diffuse agriculture, nutrition, education, and public health innovations. The newly published book provided a useable framework” (Singhal, 2012, p. 850). Rogers spent his entire career in diffusion theory and in 1991 one of his colleagues credited him with founding diffusion as an entire sub-discipline in communication research (Singhal, 2012).

Rogers defined diffusion as “the process by which an innovation is communicated through certain channels over time among members of a social system” (Rogers, 2003, p. 11). Most communication research involves messages that are familiar or anticipated. Diffusion involves unanticipated information because by its very definition, the communication includes information about an innovation – or something completely new – to the person receiving the message. The receiver then decides whether or not to seek more information about this innovation, and perhaps whether or not they are interested in adopting it. Rogers calls this decision-making process the Innovation-Decision Process. A message-receiver’s prior attitudes and conditions will determine whether or not the person wants knowledge about an innovation. This is based on whether or not they are innovative people who like to try new things or if they recognize a problem that needs to be addressed and are interested in an innovation to fix it. This is what will influence a person's decision to enter into the Innovation-Decision Process (Figure 3), which has five stages: knowledge, persuasion, decision, implementation, and confirmation.

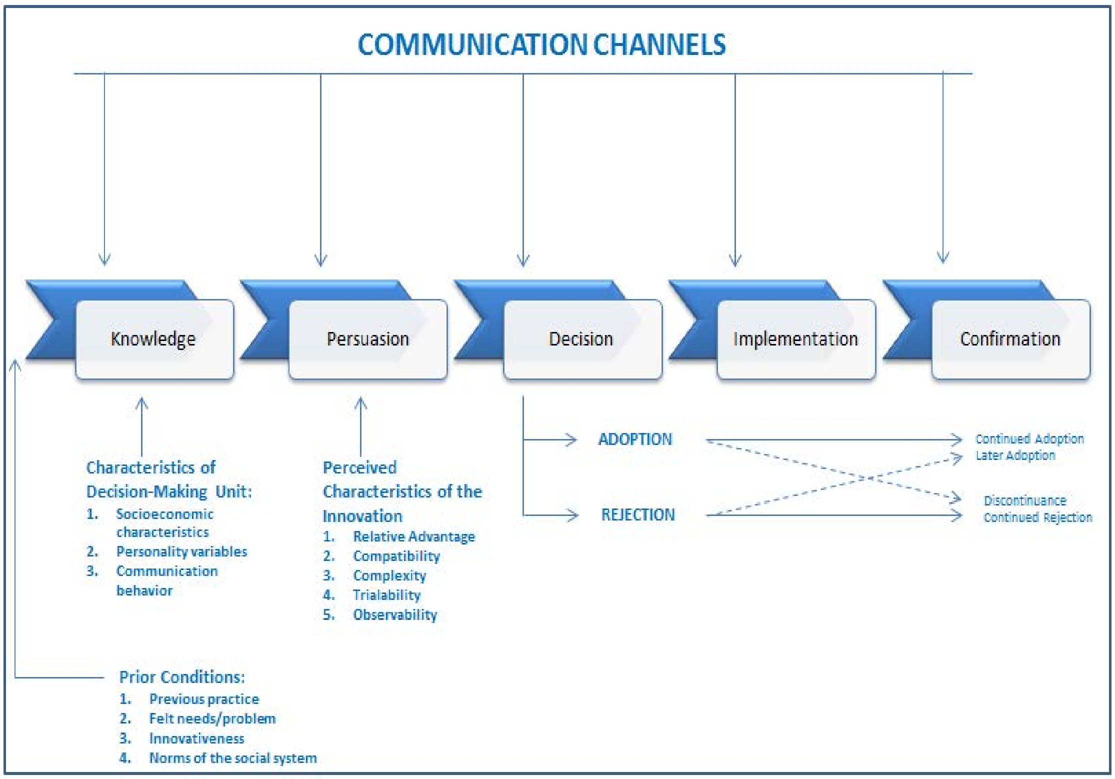


Figure 4. Model of the Five Stages of the Innovation-Decision Process. From *Diffusion of Innovations*, by E.M. Rogers, 2003, New York, N.Y.: The Free Press, a Division of Simon and Schuster. Copyright 2003 by Simon and Schuster. Reprinted with permission.

Personal characteristics of decision-makers, their communication practices, and socioeconomic factors influence people in the Knowledge Stage. Once a person is open to an innovation, can afford it, and learns of its existence and how it functions in the Knowledge Stage, they seek more information about the innovation. This informationseeking behavior is the Persuasion Stage. Persuasion information can be positive or negative. The Persuasion Stage is the stage where the characteristics of the innovation itself will influence the next stage of the process, which is the Decision Stage. This is where the decision to adopt or reject an innovation happens. However, Rogers argues that is not the end of the process. Once an adopter starts using the innovation in the Implementation Stage, they can still decide to reject the innovation or they may alter the innovation's initial intent to meet their own needs. If, during the Decision Phase, an adopter rejects the innovation, they can still change their minds in either the Implementation or Confirmation Stage. The same goes for those who chose to adopt. Once they have reached the Confirmation Stage, an adopter can cease usage of the innovation (Rogers, 2003; Ward, 2013).

Within this overall decision-making process is the heart of DoI theory. There are four elements that can be identified in every diffusion study, whether the researcher is working within the Innovation-Decision Process explained above; within any of the five variable sets explained below; or applying the entirety of DoI Theory. The elements, which include an innovation, communication channels, time, and a social system, are easily identifiable in every diffusion study (Rogers, 2003). For example, in this study the innovation being diffused was LMS technology; the communication channels included all of the ways in which an end-user could have become aware of the innovation; the time element was encompassed in the recall of end-users about their decision to adopt or not adopt the innovation; and the social system was fire service instructors. These four common elements are typically studied in either the entire DoI theory as a whole, or in one of the five variable sets that make up DoI Theory.

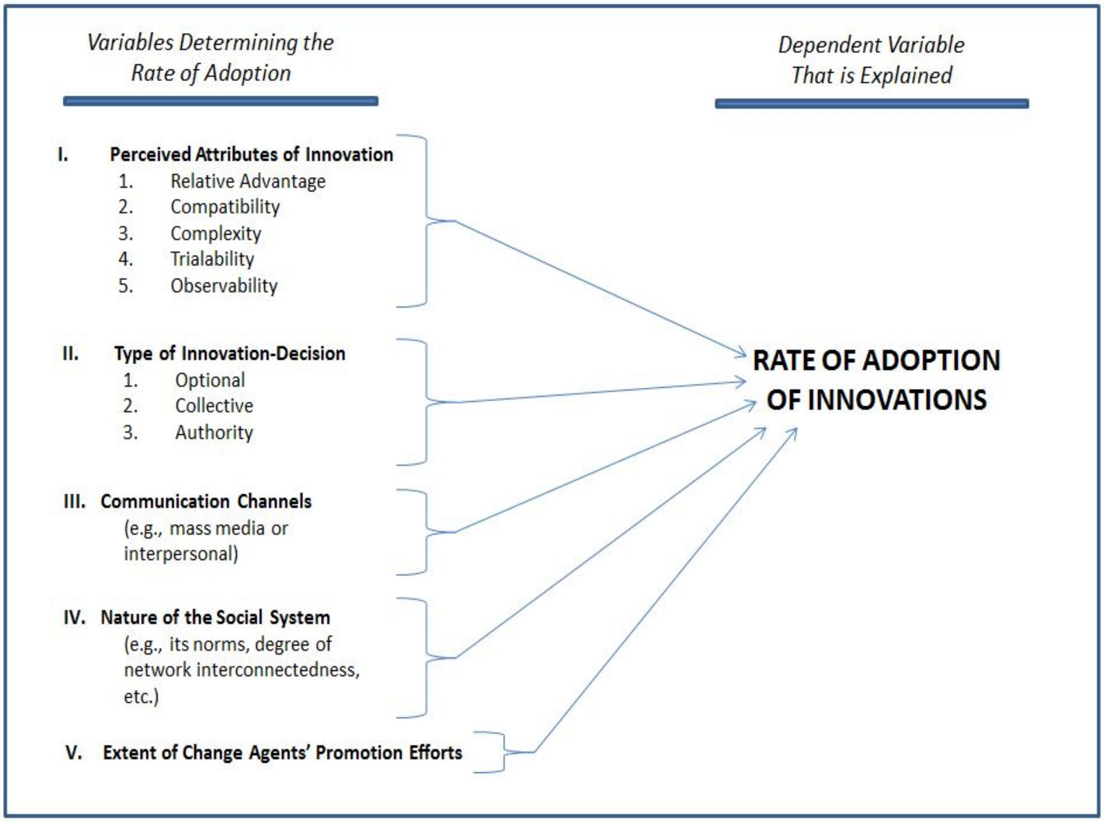


Figure 5. Conceptual Framework of all Five Variable Sets Included in Diffusion of Innovation Theory. From *Diffusion of Innovations,* by E.M. Rogers, 2003, New York, N.Y.: The Free Press, a Division of Simon and Schuster. Copyright 2003 by Simon and Schuster. Reprinted with permission.

These five independent variable sets (Figure 5), used as a whole, can determine the rate of adoption of an innovation. However, many diffusion studies typically utilize just one of the variable sets, depending upon the purpose of the study. As Table 3 shows, the first variable set, perceived attributes of innovations, is used to determine how much the five listed attributes of an innovation impact the rate of adoption. Perceived attributes are considered significant predictors when it comes to adoption (Rogers, 2003; Sahin, 2006). The second variable set focuses on how and who gets to make the ultimate decision to adopt. The wheels of bureaucracy move slowly, so the more individual the decision, the faster an innovation will diffuse. The third variable set studies the impact of communication channels on adoption rates. Rogers illustrates this in a case study brief about the diffusion of the news of the September 11, 2001, terrorist attacks. Because the coverage in the mass media was so intensive, his study was able to measure the diffusion of events in hours and minutes instead of weeks, months, or years (Rogers, 2003). The third variable set focuses on the social system characteristics of potential adopters. This set often looks at the hierarchy of the social system, the homophily and heterophily of the group, and accessibility of the opinion leaders. The last variable set concentrates on how change agents impact adoption.

Table 3

Diffusion of Innovations Variable Sets

Variable Set	Description	Impact on Adoption
Perceived Attributes of Innovations 1. Relative advantage 2. Compatibility 3. Complexity 4. Trialability 5. Observability	These are the characteristics or attributes of an innovation that explain whether or not an innovation will be adopted.	These variables explain "most of the variance, from 49 to 87 percent, in the rate of adoption" (Rogers, 2003, p. 221). This is the variable set being used for this study. The fire instructors' perceptions of these attributes can provide insight into the decision to adopt LMS technology.
Type of Innovation-Decision 1. Optional 2. Collective 3. Authority	The decision to adopt an innovation can be a personal option, a collective decision, or a mandate. The type of decision-making practice impacts the speed of adoption.	"Innovations requiring an individual-optional innovation-decision are generally adopted more rapidly that when an innovation is adopted by an organization" (Rogers, 2003, p.221).

Communication Channels Mass media, interpersonal, etc.	The way a potential adopter becomes aware of an innovation impacts the rate of adoption.	The overall adoption rate of an innovation is slowed when interpersonal channels are the main source of awareness-knowledge for potential adopters. This is especially true for later adopters (Rogers, 2003).
Nature of the Social System Norms, degree of interconnectedness, etc.	The norms within the social system under study and how connected the system is impact the rate of adoption.	The more potential adopters hear about innovations from their peers, good or bad, impacts their adoption decisions.
Change Agent Efforts	Change agents are people who promote or provide information support about the innovation. Their level of effort can impact adopter decisions.	Even though change agents are usually there to promote the innovation, they are not typically the reason a large number of people adopt. Their impact is seen when "opinion-leaders" in a peer group or social system decide to adopt an innovation (Rogers, 2003).

The first variable set, perceived attributes of innovations, was selected for this study because it is often the set selected to study technological innovations (Burrough, 2015; Chen et al., 2002; Dearing, 2009; Fasteen, 2016; Hsu, 2016; Lee et al., 2011; Miller & Bull, 2013). While the first research using this variable set was used to study technological advances with farmers, Rogers (2003) indicated that later studies conducted with teachers and school administrators made this variable set of DoI useful in predicting the adoption of educational innovations. It has been used in education to study the newest education technology in a variety of educational settings for nursing or medical fields (Burrough, 2015; Doyle et al., 2014; Miller & Bull, 2013; Ward, 2013), hospitality (Hsu, 2016), workforce training (Chen, 2014; Lee et al., 2011), and higher education

(Coskuncay & Ozkan, 2013; Surry, 1997). It also has widespread application to new technology innovations outside of education, like government services, online services, banking, and social interventions (Chen et al., 2002; Chen, 2014; Dearing, 2009; Fasteen, 2016; Gouws & van Reede von Oudushoorn, 2011; Reggi et al., 2014, Sahin, 2006). In 2003, Rogers said that the same five attributes had been used consistently for "the past 50 years or so" (Rogers, 2003, p. 223) and it had not changed. "The individuals' perceptions of the attributes of an innovation, not the attributes as classified objectively by experts or change agents, affect its rate of adoption" (Rogers, 2003, p. 223). The five attributes Rogers devised from literature and his own research include: relative advantage, compatibility, complexity, trialability, and observability.

Relative Advantage

Relative advantage is defined as "the degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers, 2003, p. 229). It is considered one of the best predictors for adoption and many studies showed a positive relationship between this variable and rate of adoption (Lee et al., 2011; Rogers, 2003). The advantage a potential adopter sees in an innovation can be more than just it being improved over prior ideas or practices. The advantage can also be financial or even a perception of a change in social status. The hypotheses for relative advantage in this study included:

H1.1: The relative advantages of LMS technology have a positive effect on perceived usefulness of LMS technology.
H1.2: The relative advantages of LMS technology do not affect the perceived ease of use of LMS technology.
H1.3: The relative advantages of LMS technology do not affect the intent to adopt and use of LMS technology.

Compatibility

Compatibility is defined as “the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters” (Rogers, 2003, p. 240). In education, instructors often related a new concept with something that was already known to students so it was easier to accept and learn. Compatibility is very much the same. The more compatible a potential adopter perceives the new innovation to be with their existing beliefs, practices, and knowledge, the more likely they are to adopt. Compatibility is typically positively related to the rate of adoption. The hypotheses for compatibility in this study included:

H2.1: Compatibility of LMS technology has a positive effect on perceived usefulness of LMS technology.
H2.2: Compatibility of LMS technology has a positive effect on perceived ease of use of LMS technology.
H2.3: Compatibility of LMS technology has a positive effect on the intent to adopt and use of LMS technology.

Complexity

Complexity is defined as “the degree to which an innovation is perceived as relatively difficult to understand and use” (Rogers, 2003, p. 257). If a potential adopter thinks the new innovation is too complicated, they are less likely to adopt it. Therefore, this variable is negatively related to the rate of adoption. The hypotheses for complexity in this study included:

H3.1: Complexity of LMS technology negatively affects perceived usefulness of LMS technology.
H3.2: Complexity of LMS technology negatively affects perceived ease of use of LMS technology.
H3.3: Complexity of LMS technology negatively affects the intent to adopt and use of LMS technology.

Observability

Observability is defined as “the degree to which the results of an innovation are visible to others” (Rogers, 2003, p. 258). This variable is also positively related to the rate of adoption. Observability is not just about seeing the results of the innovation, it can also be impacted by whether or not people within a social network see other people within their group using the new innovation and using it successfully. The hypotheses for observability in this study included:

H4.1: Observability of LMS technology has a positive effect on perceived usefulness of LMS technology.
H4.2: Observability of LMS technology has a positive effect on perceived ease of use of LMS technology.
H4.3: Observability of LMS technology has a positive effect on the intent to adopt and use of LMS technology.

Trialability

Trialability is defined as “the degree to which an innovation may be experimented with on a limited basis” (Rogers, 2003, p. 258). This is simply “try it before you buy it” and is therefore positively related to the rate of adoption. It is also positively related to other variables within the set. The more exposure a potential adopter has to a new innovation, the less complex the innovation seems and the more compatible to their needs it seems, the more likely it is that they will perceive that adoption has a higher relative advantage. The hypotheses for trialability in this study included:

H5.1: Trialability of LMS technology has a positive effect on perceived usefulness of LMS technology.
H5.2: Trialability of LMS technology has a positive effect on perceived ease of use of LMS technology.
H5.3: Trialability of LMS technology has a positive effect on the intent to adopt and use learning management systems.

These five variables are considered a classic issue and area of study in diffusion research (Moore & Benbasat, 1991; Rogers et al., 2009) and have been used extensively in the study of technology diffusion (Burrough, 2015; Chen, 2014; Dearing, 2009; Doyle et al., 2014; Hsu, 2015; Miller & Bull, 2013; Singh & Hardaker, 2014; Reggi et al., 2014; Gouws & van Reede von Oudtshoorn, 2011; Singhal, 2012; Surry, 1997).

Technology Acceptance Model

The technology acceptance model, or TAM, is widely used when studying whether or not a person will accept a new piece of technology (Carter & Belanger, 2005; Chen et al., 2002; Lee, Kozar, & Larsen, 2003; Marangunic & Granic, 2015; Walker, 2014; Ward, 2013). Fred D. Davis, like Everett Rogers, first wrote about his model in his doctoral dissertation. In his 1986 paper, he presented a model for technology acceptance he theorized would “improve understanding of user acceptance processes” and provide a testing methodology that would provide technology designers a way to “evaluate proposed new systems prior to their implementation” (Davis, 1986, p. 7).

A historical perspective is helpful to better understand TAM. In the late 1970s and early 1980s many people were introduced to computer technology at work, but it was when the personal computer entered people’s homes that the technology really took off (Davis, 1986). Apple II computers hit the market in 1977. Apple gave thousands of computers to schools, giving kids their first exposure to computer technology. This was also the year Atari introduced its first gaming system, the first of its kind to successfully use interchangeable game cartridges. It was also the year that Radio Shack introduced the

TRS-80, one of the first popular home computers. The White House got computers in 1978.

Each year in the 1980s saw new technologies emerge. The decade was the heyday for personal computing and put new technology in the hands of more individuals than ever in the workforce and at home (Davis, 1986). In 1981, IBM released its first personal computer. Because of the IBM brand and a very successful marketing campaign, it became the preferred PC adopted in business and industry. In 1982, *TIME Magazine* replaced its famed “Man of the Year” with “Machine of the Year” and named the personal computer. Also in that year, LAN systems, like Ethernet, which connected computers and peripherals in offices, were developed. It was also 1982 when Commodore introduced the Commodore 64, which ended up selling over 22 million units by the time it was pulled from the market in 1993. It is recognized in the Guinness Book of World Records as the “greatest selling single computer of all time” (Computer History Museum, 2017). Microsoft Word was introduced in 1983 and overtook WordPerfect as the global standard by 1989. In 1984, Apple launched the Macintosh, the first computer to feature a mouse, in a Super Bowl ad that depicted IBM as George Orwell’s “Big Brother”. This was also the year that CD-ROMs were introduced, taking multimedia to a whole new level (Computer History Museum, 2017). The technological advances impacting individuals in their workplace and in their home was a whirlwind and with it revealed the problem that still persists today: technology acceptance. In 1989, Davis et al. (1989) noted: “Computer systems cannot improve organizational performance if they aren’t used. Unfortunately, resistance to end-user systems by managers and professionals is a widespread problem” (pg. 982).

The intent of TAM is to apply it to “any specific domain of human-computer interaction” (Lee et al., 2011, p. 125). TAM uses two end-user opinions to determine whether or not a new technology will be adopted: perceived usefulness (PU) and perceived ease of use (PEU). Perceived usefulness is the degree to which the user perceives the technology as useful in their job. The perceived ease of use is the degree of difficulty a user faces when using the technology (Davis et al., 1989).

To get to these two end-user opinions, Davis looked to psychology. TAM was born from the theory of reasoned action (TRA) and, by extension, the theory of planned behavior (TPB) studied extensively by Martin Fishbein and Icek Ajzen. Literature reviews from Lee et al. (2003) and Marangunic and Granic (2015) provide in-depth information into its uses and a very succinct overview of the theoretical beginnings, respectively.

Theory of Reasoned Action (TRA)

TRA theorizes that a person’s intention to act upon something only occurs after that person weighs the positives and negatives of the decision and the subjective norms attached to the decision. This intent to act and subsequent behavior occurs in a systematic and rational way. For example, if a person thinks the decision to adopt a new technology will have a positive impact on their life, their positive attitude will lead to a decision to adopt, or the intention to adopt. This subsequently leads to the act of actually adopting it. If this positive attitude is complemented by positive attitudes from the people close to them, i.e., peer group, family, etc., the intention to act and subsequent adoption is even more likely to occur. “TRA looks at the behavioral intentions rather than the attitudes as the main predictors of behaviors," (Fishbein & Ajzen, 1975; Marangunic & Granic, 2015, p. 84). As happens with research into new theories, once the TRA started being used in research studies, inadequacies and limitations were identified. One of these limitations was that the theory did not consider external factors that could prevent even the best of intentions. As a result, a new element, perceived behavioral control, was added and the theory became the theory of planned behavior (TPB).

Theory of Planned Behavior (TPB)

"At the heart of the TPB is the individual's intention to perform a given behavior" (Fishbein & Ajzen, 1975; Marangunic & Granic, 2015, p. 84). This theory kept the basics of TRA in that a person's intent to perform a certain behavior is influenced by their attitudes about the behavior itself and what outside influences motivate them to perform the behavior and added a variable that takes into consideration whether or not he or she can confidently perform the behavior. Take the example above a step further and add to it that the cost of the new technology is prohibitive. The expense of adopting the new technology may impede a person's intent to adopt regardless of positive intentions. This information is valuable in that it can be used to predict intended behavior and when and where to interject strategies to increase desired behaviors.

TPB was often used in research into technology, but fell short when applied to all of the different iterations of technology available. This led Davis to propose TAM with some minor modifications that included only considering a potential user's attitude toward the technology itself and identifying perceived ease of use (PEU) and perceived usefulness (PU) as variables that determine intent to use or adopt technology. Design features, or characteristics of a technology impact these two variables, which ultimately shapes a user's attitude and intent to use or adopt technology.

Perceived Ease of Use (PEU)

Perceived ease of use (PEU) is the "degree to which an individual believes that using a particular system would be free of physical and mental effort" (Davis, 1986, p. 26). Ease of use has a direct impact on perceived usefulness. For example, if fire service instructors perceived LMS technology as easy to use, they were more likely to see the technology as useful to them and, as a result, they would adopt the technology.

H6.1: PEU of LMS technology has a positive effect on the PU of learning management systems.

Perceived Usefulness (PU)

Perceived usefulness (PU) is the "degree to which an individual believes that using a particular system would enhance his or her job performance" (Davis, 1986, p. 26). Usefulness does not have a direct impact on ease of use, but it does ultimately influence intention and actual use. For example, if fire service instructors perceive LMS technology as useful to them professionally or even personally, they were more likely to adopt and use the technology.

H7.1: PU of LMS technology has a positive effect on the intention to adopt and use learning management systems.

DoI and TAM

Rogers' Diffusion of Innovation Theory and Davis' Technology Acceptance Model both have long histories of successful research into user attitudes about and the adoption of new technology (Burrough, 2015; Chen et al., 2002; Chen, 2014; Dearing, 2009; Doyle et al., 2014; Fasteen, 2016; Gouws et al., 2011; Hsu, 2016; Lee et al., 2003; Lee et al., 2011; Marangunic & Granic, 2015; MacVaugh & Schiavone, 2010; Miller & Bull, 2013; Moore & Benbasat 1991; Reggi et al., 2014; Rogers, 2003; Rogers et al., 2009; Ryan & Gross, 1943; Singhal, 2012; Surry, 1997; Walker, 2014; Ward, 2013; Wu & Wang, 2005). However, as technology changes and moves forward, researchers continue to look for new and innovative ways to advance research into end-user attitudes as well. Just as Everett Rogers looked to Gabriel Tarde and George Simmel for DoI and Fred Davis looked to the psychological theories for TAM, current researchers review existing theories and methods and look for ways to use them, and even improve upon them, to move research forward. In this spirit, several researchers have combined DoI with TAM, to make each of them more applicable to the ever-changing technology landscape and to make each of the theories' findings and predictions stronger (Bousbahi & Alrazgan, 2015; Carter & Belanger, 2005; Chen et al., 2002; Lee et al., 2011; Legris, Ingham, & Colerette, 2003; Lim, 2008; Moore & Benbasat, 1991; Ward, 2013; Wong, Tatnall, & Burgess, 2013; Wu & Wang, 2005). While the two theories started in different topic areas, they have several similarities. Relative advantage from DoI is often compared to the PU element of TAM and the complexity element from DoI is often compared to the PEU element of TAM (Carter & Belanger, 2005; Chen et al., 2002; Lee et al., 2011; Lim, 2008; Wu & Wang, 2005). It could be argued that the perceived attributes of innovations from DOI used in this study – relative advantage, complexity, compatibility, trialability, and observability – fit into the TAM research framework as the design features (Lee et al., 2011).

Research by Lee et al. in 2011 combined DoI and TAM to study employee adoption of e-learning systems for workforce training. Chen et al. used the combination to study the adoption of virtual stores in 2002. Although it is probably hard to imagine in 2018, adoption of online stores for shopping also suffered from system usage issues when the technology was first introduced (Chen et al., 2002). Lim used the combination of the two theories to study adoption of electronic marketing channels in the hospitality industry (2009) and Carter and Belanger (2005) integrated the two theories to study user adoption of electronic government services. Joseph (2008) combined the two theories to study the adoption of LMS technology by the faculty at historically black colleges and universities. Wu and Wang (2005) used a later variation of TAM, called TAM2, combined with DoI to study wireless communication technology for mobile commerce.

Summary

Fire service training, as a discipline, has received little attention by researchers despite the life and death subject matter. Including this population in a study that used SEM to test existing hypotheses from two topics with rich research histories, Rogers' Diffusion of Innovations and Davis' Technology Model, hopefully provided a baseline from which other research can be pursued.

CHAPTER III

METHODS

The purpose of this quantitative study was to explore the adoption behaviors regarding one type of educational technology, Learning Management Systems (LMS), by fire service instructors using survey research design. The study used descriptive statistics and structural equation modeling (SEM) to explore the relationships between the variables and to test the model proposed in this study to determine if it supported the theoretical hypotheses as they applied to fire service instructors. This chapter describes the methods used in this study including the research design, population information, instrumentation, procedures and timelines, data collection and analysis, and ethical considerations.

Research Questions and Hypotheses

The hypotheses and research questions for this study were adapted and modified from existing literature to apply to this study (Agarwal and Prasad, 1999; Hardgrave et al., 2003; Lee et al., 2011; Wu & Wang, 2005).

Relative Advantage

H1.1$_0$: The relative advantages of LMS technology do not affect the perceived usefulness of LMS technology.

$H1.1_1$: The relative advantages of LMS technology have a positive effect on perceived usefulness of LMS technology.
$H1.1_0$: $\mu = 0$
$H1.1_1$: $\mu \neq 0$

$H1.2_0$: The relative advantages of LMS technology do not affect the perceived ease of use of LMS technology.
$H1.2_1$: The relative advantages of LMS technology have a positive effect on perceived ease of use of LMS technology.

$H1.2_0$: $\mu = 0$
$H1.2_1$: $\mu \neq 0$

$H1.3_0$: The relative advantages of LMS technology do not affect the intent to adopt and use of LMS technology.
$H1.3_1$: The relative advantages of LMS technology have a positive effect on the intent to adopt and use of LMS technology.

$H1.3_0$: $\mu = 0$
$H1.3_1$: $\mu \neq 0$

RQ1: Is the relative advantage of LMS technology correlated with the intent to adopt LMS technology?

Compatibility

$H2.1_0$: Compatibility of LMS technology does not affect perceived usefulness of LMS technology.
$H2.1_1$: Compatibility of LMS technology has a positive effect on perceived usefulness of LMS technology.

$H2.1_0$: $\mu = 0$
$H2.1_1$: $\mu \neq 0$

$H2.2_0$: Compatibility of LMS technology does not affect perceived ease of use of LMS technology.
$H2.2_1$: Compatibility of LMS technology has a positive effect on perceived ease of use of LMS technology.

$H2.2_0$: $\mu = 0$
$H2.2_1$: $\mu \neq 0$

$H2.3_0$: Compatibility of LMS technology does not affect the intent to adopt and use of LMS technology.

$H2.3_1$: Compatibility of LMS technology has a positive effect on the intent to adopt and use of LMS technology.

$H2.3_0$: $\mu = 0$
$H2.3_1$: $\mu \neq 0$

RQ2: Is the compatibility of LMS technology correlated with the intent to adopt LMS technology?

Complexity

$H3.1_0$: Complexity of LMS technology does not affect perceived usefulness of LMS technology.
$H3.1_1$: Complexity of LMS technology negatively affects perceived usefulness of LMS technology.

$H3.1_0$: $\mu = 0$
$H3.1_1$: $\mu \neq 0$

$H3.2_0$: Complexity of LMS technology does not affect perceived ease of use of LMS technology.
$H3.2_1$: Complexity of LMS technology negatively affects perceived ease of use of LMS technology.

$H3.2_0$: $\mu = 0$
$H3.2_1$: $\mu \neq 0$

$H3.3_0$: Complexity of LMS technology does not affect the intent to adopt and use of LMS technology.
$H3.3_1$: Complexity of LMS technology negatively affects the intent to adopt and use of LMS technology.

$H3.3_0$: $\mu = 0$
$H3.3_1$: $\mu \neq 0$

RQ3: Is complexity of LMS technology correlated to the intent to adopt LMS technology?

Observability

$H4.1_0$: Observability of LMS technology does not affect perceived usefulness of LMS technology.

H4.1$_1$: Observability of LMS technology has a positive effect on perceived usefulness of LMS technology.

H4.1$_0$: $\mu = 0$
H4.1$_1$: $\mu \neq 0$

H4.2$_0$: Observability of LMS technology does not affect perceived ease of use of LMS technology.
H4.2$_1$: Observability of LMS technology has a positive effect on perceived ease of use of LMS technology.

H4.2$_0$: $\mu = 0$
H4.2$_1$: $\mu \neq 0$

H4.3$_0$: Observability of LMS technology does not affect the intent to adopt and use of LMS technology.
H4.3$_1$: Observability of LMS technology has a positive effect on the intent to adopt and use of LMS technology.

H4.3$_0$: $\mu = 0$
H4.3$_1$: $\mu \neq 0$

RQ4: Is observability of LMS technology correlated to the intent to adopt LMS technology?

Trialability

H5.1$_0$: Trialability of LMS technology does not affect perceived usefulness of LMS technology.
H5.1$_1$: Trialability of LMS technology has a positive effect on perceived usefulness of LMS technology.

H5.1$_0$: $\mu = 0$
H5.1$_1$: $\mu \neq 0$

H5.2$_0$: Trialability of LMS technology does not affect perceived ease of use of LMS technology.
H5.2$_1$: Trialability of LMS technology has a positive effect on perceived ease of use of LMS technology.

H5.2$_0$: $\mu = 0$
H5.2$_1$: $\mu \neq 0$

H5.3$_0$: Trialability of LMS technology does not affect the intent to adopt and use learning management systems.
H5.3$_1$: Trialability of LMS technology has a positive effect on the intent to adopt and use learning management systems.

H5.3$_0$: $\mu = 0$
H5.3$_1$: $\mu \neq 0$

RQ5: Is trialability of LMS technology correlated to the intent to adopt LMS technology?

Perceived Ease of Use

H6.1$_0$: Perceived ease of use of LMS technology has no effect on the perceived usefulness of learning management systems.
H6.1$_1$: Perceived ease of use of LMS technology has a positive effect on the perceived usefulness of learning management systems.

H6.1$_0$: $\mu = 0$
H6.1$_1$: $\mu \neq 0$

RQ6: Is perceived ease of use of LMS technology correlated the perceived usefulness of LMS technology?

Perceived Usefulness

H7.1$_0$: Perceived usefulness of LMS technology has no effect on the intention to adopt and use learning management systems.
H7.1$_1$: Perceived usefulness of LMS technology has a positive effect on the intention to adopt and use learning management systems.

H7.1$_0$: $\mu = 0$
H7.1$_1$: $\mu \neq 0$

RQ7: Is perceived usefulness of LMS technology correlated with the intent to adopt LMS technology?

RQ8: Does the proposed research model align with theoretical hypotheses as they apply to fire service instructors?

Research Design

The questions in this study were best answered through a quantitative research design that utilized a cross-sectional survey tool (Creswell, 2009; Creswell & Creswell, 2018). Descriptive statistics were used to make generalizations and predictions about the adoption behaviors of the group researched and SEM was used to analyze the hypotheses to determine if the proposed research model aligned with proposed theoretical hypotheses as they applied to fire service instructors. Because this population, fire service instructors, had not been studied (Childs, 2005; Donahue et al., 2010; Holmgren, 2014a; Shay, 2010; Wener et al., 2015) this research started from the beginning of this topic with a potentially large group of people whose opinions needed to be gathered and reviewed. According to Salkind, quantitative research is used for “describing, organizing, and interpreting information or data,” (2011, p. 7). The combination of descriptive and SEM analysis provided a more complete picture of the statistical relationships that may exist between the variables in the study.

Survey research provided a numeric illustration of which attributes of LMS technology influence fire service instructors’ likelihood to adopt the technology. Fraenkel, Wallen, and Hyun (2012) describe the purpose of survey research as a way to describe the “characteristics of a population” (p. 393). Cross-sectional surveys, like the one used in this study, call for the collection of data from a sample of a population. Surveys are a very common quantitative research tool, especially when the recipient sample list is large, as in this study. According to Creswell, survey research provides a “numeric description of trends, attitudes, or opinions of a population by studying a sample of that population” (Creswell, 2009, p. 145). This approach is commonly used when testing the hypotheses related to DoI and TAM (Burrough, 2015; Gouws et al., 2011; Lee et al., 2011; Reggi et al., 2014; Walker, 2014).

This study used a web-based questionnaire for data collection. There are several advantages to web-based survey delivery including convenience, lower costs, the ability to access the survey on various devices, and less chance of data entry mistakes because data sets can be uploaded directly into statistics analysis software (Fraenkel et al., 2012). Conducting this study via a web link ensured that fire instructors from multiple geographic areas had the opportunity to engage and access the survey with various types of technology. The study required the respondents to provide their personal responses to statements about the characteristics of LMS technology and this methodology supported that requirement. To ensure content validity, the items chosen for the quantitative instrument were adapted from existing research (Davis et al., 1989; Lee et al., 2011; Moore & Benbasat, 1991; Taylor & Todd, 1995; Karahanna, Straub, & Chervany, 1999).

Population and Sample

The population for this study included fire service training instructors with access to LMS technology in the United States. For the purpose of this study, fire service training instructors were defined as any fire staff member who currently teaches or has taught fire safety courses to fire trainees or personnel, whether they were career firefighters or volunteers. There were no requirements for participation that were based on the amount of experience they had as instructors, how often they taught classes, or whether or not they were currently teaching. This sample could include NFPA®-certified or non-certified instructors, beginning instructors, fire service officers, or fire staff assigned to teach continuing education lessons.

At the time of this research, no organization tracked the exact number of fire service instructors in the United States. However, attendance numbers for the main professional conference for fire instructors, Fire Department Instructors Conference (FDIC), offered some insight into the possible numbers. According to the FDIC International Facebook page, the conference had consistently hosted between 30,000 and 35,000 attendees from over 50 countries since 2012 (FDIC International, 2013; FDIC International, 2016). Unfortunately, that organization did not provide any further breakdown of those attendance numbers, so it was unknown whether that total included vendors and other attendees who were not instructors. Because the number of fire instructors was unknown, the researcher used a purposive sample of 2,690 fire service instructors obtained from Fire Protection Publications (FPP)/International Fire Service Training Association (IFSTA), which is headquartered within the College of Engineering, Architecture, and Technology, at Oklahoma State University. FPP/IFSTA, founded in 1934, is the largest producer of firefighter training materials in the world and provides free LMS technology to fire instructors. This purposive sample was assumed to be representative of the population because the sample met the criteria set for the study: fire instructors with access to free LMS technology. According to Teddlie and Yu (2007), one of the goals of this type of sampling is to represent common characteristics, based on areas of interest, of the population under study.

Instrumentation

The 27-question, self-administered online survey instrument for this study was adapted with permission from a 2011 study conducted by Lee et al. to study the adoption of e-learning technology in workforce settings in Taiwan. The researcher for this study contacted Lee and asked for permission to use and adapt the instrument validated during their study. The previous researchers provided the instrument. The research for this study used all the items from the 2011 study, but adapted the language to specifically address LMS technology. This modification consisted exclusively of 27 word replacements, i.e., Lee et al. used “e-learning system” in the instrument items. This study substituted the term “learning management system” or “LMS” instead, as it was the appropriate term for this inquiry. Before the survey was distributed to the sample, an expert panel of five fire service instructors reviewed the instrument for readability, usability, and validity for this research project. The fire service instructors were provided a copy of the instrument via email and were given five days to respond. All five responded. The only revisions required consisted of four typing and grammatical errors with no changes to the content. Nothing in the reviews indicated any cultural concerns with the instrument.

Once the Institutional Review Board at Oklahoma State University approved the project, the instrument, available in Appendix A, was sent via link using Qualtrics in an introductory e-mail from the researcher. The instrument began with the required information sheet about the survey, as well as consent information. Once a respondent decided to participate, they were presented with the instrument, which defined LMS and provided the names of different types of LMS products, before the items, presented one at a time, began. The first two sections collected data in five-point Likert-type scales with values defined as:

- 1 = Strongly disagree
- 2 = Disagree
- 3 = Neither agree nor disagree
- 4 = Agree
- 5 = Strongly agree

Diffusion of Innovation

The first set of items in the instrument used Likert-type scales to ask 18 level of agreement with statements about the five characteristics from DoI: compatibility (COM), complexity (CMP), relative advantage (REL), observability (OB), and trialability (TRI).

Table 4

Instrument Items for Diffusion of Innovation Attributes

Item	Attribute	Hypothesis & Research Question
I think that using LMS technology fits well/will fit well with the way I like to work.	Compatibility	H2.1 H2.2 H2.3 RQ2
Using LMS technology fits/will fit into my work style.	Compatibility	H2.1 H2.2 H2.3 RQ2
Using LMS technology is appropriate for my teaching style.	Compatibility	H2.1 H2.2 H2.3 RQ2

Using LMS technology is compatible with most of my teaching.	Compatibility	H2.1 H2.2 H2.3 RQ2
Learning LMS technology was/will be easy for me.	Complexity	H3.1 H3.2 H3.3 RQ3
I think LMS technology is clear and understandable.	Complexity	H3.1 H3.2 H3.3 RQ3
I think LMS technology is/will be easy to use.	Complexity	H3.1 H3.2 H3.3 RQ3
Using LMS technology enables/will enable me to accomplish tasks more quickly.	Relative Advantage	H1.1 H1.2 H1.3 H1.4 RQ1
Using LMS technology improves/will improve the quality of the work I do.	Relative Advantage	H1.1 H1.2 H1.3 H1.4 RQ1
Using LMS technology makes it/will make it easier to do my job.	Relative Advantage	H1.1 H1.2 H1.3 H1.4 RQ1
Using LMS technology enhances/will enhance my effectiveness on the job.	Relative Advantage	H1.1 H1.2 H1.3 H1.4 RQ1
Using LMS technology increases/will increase my productivity.	Relative Advantage	H1.1 H1.2 H1.3 H1.4 RQ1
Before deciding on whether or not to use LMS technology, I saw a lot of others in my field using LMS technology.	Observability	H4.1 H4.2 H4.3 RQ4
Before deciding on whether or not to use LMS technology, I saw demonstrations of LMS technology.	Observability	H4.1 H4.2 H4.3 RQ4

Before deciding on whether or not to use LMS technology, I did not see many people using LMS technology.	Observability	H4.1 H4.2 H4.3 RQ4
Before deciding on whether or not to use LMS technology, I was permitted to use it long enough to see what it could do.	Trialability	H5.1 H5.2 H5.3 RQ5
Before deciding on whether or not to use LMS technology, I was able to try its various options.	Trialability	H5.1 H5.2 H5.3 RQ5
Before deciding on whether or not to use LMS technology, I already had a task in mind to test it.	Trialability	H5.1 H5.2 H5.3 RQ5

Technology Acceptance Model

The second section of the instrument came from the TAM model and was adapted from Davis et al. (1989), Lee et al. (2011), and Venkatesh and Davis (2000). It also contained Likert-type scales, the same as mentioned above, to obtain levels of agreement with nine statements about the constructs of TAM and adoption intentions: perceived usefulness (PU), perceived ease of use (PEU), and intention (INT).

Table 5

Instrument Items for the Main Constructs of the Technology Acceptance Model (TAM)

Question	Construct	Hypothesis & Research Question
Using LMS technology enhances/will enhance my effectiveness as a teacher.	Perceived Usefulness	H7.1 RQ7
Using LMS technology will improve my teaching performance.	Perceived Usefulness	H7.1 RQ7
Using LMS technology will make it easier to teach course content.	Perceived Usefulness	H7.1 RQ7
I find LMS technology to be easy to use.	Perceived Ease of Use	H6.1 RQ6
It is easy to perform work using LMS technology.	Perceived Ease of Use	H6.1 RQ6
I clearly understand how to use LMS technology.	Perceived Ease of Use	H6.1 RQ6
I intend to use or continue using LMS technology in the next 6 months.	Intention	H1.3 H2.3 H3.3 H4.3 H5.3 H7.1 RQ1-5, RQ7
I intend to use or continue using LMS technology as an autonomous learning tool.	Intention	H1.3 H2.3 H3.3 H4.3 H5.3 H7.1 RQ1-5, RQ7
I intend to use or continue using LMS technology to assist my teaching.	Intention	H1.3 H2.3 H3.3 H4.3 H5.3 H7.1 RQ1-5, RQ7

Demographics

The third section of the survey, the demographics information, first asked respondents to rate their instructor experience level in nine, five-point Likert-type scale statements with values defined as:

- 1 = No experience
- 2 = Some experience
- 3 = Fairly confident in my experience level
- 4 = Very confident in my experience level
- 5 = So confident, I could train other instructors

The final eight-question section of the instrument collected typical demographic data on gender, age, race/ethnicity, educational level, years of experience using computers, type of fire service training organization, current use of LMS technology, and types of LMS used. The demographics section was placed at the end of the survey because it was not collecting information that would be used in the current study.

Table 6

Demographic Items

Item	Category	Measurement
Interacting and collaborating with students.	Teaching Experience	Likert-type Scale
Managing classroom organization.	Teaching Experience	Likert-type Scale
Managing classroom time.	Teaching Experience	Likert-type Scale
Organizing curricular goals, lesson plans, and instructional delivery.	Teaching Experience	Likert-type Scale
Using student assessment and feedback to maximize instructional effectiveness.	Teaching Experience	Likert-type Scale
Integrating technology in the classroom.	Teaching Experience	Likert-type Scale
Developing a professional identity as an instructor.	Teaching Experience	Likert-type Scale
Enhancing professional relationships with colleagues.	Teaching Experience	Likert-type Scale
Presentation skills and teaching techniques.	Teaching Experience	Likert-type Scale
Gender	General Demographics	Multiple Choice
Age	General Demographics	Open Response
Race/Ethnicity	General Demographics	Multiple Choice
Highest Level of Education	General Demographics	Multiple Choice
Computer Experience at Work	General Demographics	Multiple Choice
Type of Fire Service Training Organization	General Demographics	Multiple Choice
Current Use of LMS	General Demographics	Multiple Choice
Types of LMS used	General Demographics	Open Response

The first two sections specified above, DoI and TAM, were not presented as two separate sections as they are in this report of the study, they were presented as individual statements with Likert-type scales indicating level of agreement with no differentiation in

DoI or TAM. The demographics section was delineated with a header to indicate the section was different from the ones previous to it.

Procedures and Timeline for Conducting the Study

Institutional Review Board approval from Oklahoma State University was received in November 2017 (Appendix C). The expert review panel described earlier received the instrument within three days and all responses were received by November 24, 2017. The researcher obtained an email mailing list of 2,690 fire service instructors with access to LMS technology. An introductory e-mail from Fire Protection Publications was sent to that list to request participation in the research study approximately one week before the survey was sent. A reminder was sent to the remaining people on the original mailing list who had not started or needed to complete the survey on December 11, 2017. The survey closed on December 18, 2017.

Data Collection

Data was collected using Qualtrics and imported into IBM SPSS Version 25 for analysis. Of the 2,690 emails sent, 80 of the emails were undeliverable. The researcher reviewed the 80 email addresses to see if there were obvious problems with extra spaces, missing “@” symbols or extensions, etc. None of these issues were found. After further review, it was determined that the email addresses were no longer valid and were removed from further email contact lists, which reduced the number of initial contacts to 2,610. This decision increased the initial response rate from 17.2% to 17.8%. Of the 2,690 surveys sent, 465 fire service instructors responded. There were 108 incomplete surveys that were either blank (50) or were started and never finished (58). The 58 surveys that were not completed were missing substantial amounts of data. A visual examination of the dataset in an Excel spreadsheet showed that those 58 cases just stopped engaging with the survey as if they had been interrupted. Even though the opportunity to return to the instrument to complete it was available and a reminder was sent, they did not. The researcher reviewed case reduction methods and data imputation methods and, based on the number of available completed surveys, chose to remove these respondents. This left 357 completed surveys for further analysis (Table 7).

Table 7

Survey Response Data by Date

Date	Responses	Completed Surveys	Incomplete Surveys
12/4/2017	144	125	19
12/5/2017	43	31	12
12/6/2017	18	13	5
12/7/2017	9	5	4
12/8/2017	5	2	3
12/9/2017	5	5	0
12/10/2017	2	2	0
12/11/2017	114	84	30
12/12/2017	18	14	4
12/13/2017	9	5	4
12/14/2017	3	3	0
12/15/2017	77	54	23
12/16/2017	8	7	1
12/17/2017	6	4	2
12/18/2017	4	3	1
Total	465	357	108

Within those 357 completed surveys, there were some isolated missing items. This is often the case with survey research and can potentially present problems in the analysis of data and interpretation of results (Gemici, Rojewski, & Lee, 2012). The missing data were analyzed using Little's MCAR test and determined to be missing completely at random (MCAR) (χ^2 (153, n=357,) = 166.681, p = .213). According to Gemici et al. (2012), MCAR means that the absence of a value in a variable is unrelated to other data points in the dataset and that "nonresponse under MCAR is therefore ignorable, since the missing values do not alter the original distributional relationships between variables" (Gemici et al., 2012, p. 82). Even though, the low number of missing items (10) was considered ignorable, the researcher chose to address the missing data using mean substitution in order to move forward with a complete data set (Gaskin, 2016b).

The demographic portion of the questionnaire included two open field responses for age which was coded into ranges, and which type of LMS respondents have used, which was gathered for informational purposes. Both of these items were retained by the researcher as comment data and not part of this analysis. Additional information was also collected about instructor experience levels for future study.

Table 8 shows that the respondents to the survey were predominately white males (93%), aged 40-59 (69%), with more than nine years of experience using computers at work (91%). Local fire departments represented 31% of the sample, followed by fire service training organizations (26%), volunteer fire departments and state fire service training organizations (16%), higher education (8%) and technical schools (3%). The majority of the sample reported that they currently use some type of LMS technology (87%).

Table 8

Demographics of the Respondents

Demographics	Number	%
Gender		
Female	23	6.4
Male	332	93
Other	2	.6
Race/Ethnicity		
White	326	91.3
Hispanic or Latino	14	3.9
Black or African American	7	2
Native American or American Indian	4	1.1
Asian/Pacific Islander	2	.6
Other	4	1.1
Age		
20-29	9	2.6
30-39	44	12.3
40-49	138	38.6
50-59	108	30.2
>60	36	10.1
Opted Out	22	6.2
Education		
High School	68	19
College/University Degree	205	28.9
Master's Degree	52	14.6
Doctoral Degree	4	1.1
Other	28	7.8

Experience with Computers in a Work Environment		
Less than a year	1	.3
1-3 years	3	.8
3-6 years	9	2.5
6-9 years	19	5.3
More than 9 years	325	91
Type of Fire Service Training Organization		
Volunteer	57	16
Department/District Fire Service Training Organization	92	25.8
State Fire Service Training Agency	56	15.7
Local Department	111	31.1
Technical School	11	3.1
Higher Education	30	8.4
Current LMS Use		
Yes	309	86.6
No	41	11.5
I Don’t Know	7	2

Data Analysis

Data analysis in this study was two-fold. First, the researcher used descriptive statistical tools available in IBM SPSS Version 25 to analyze the various constructs of DoI and TAM for adoption of LMS technology. Cronbach’s Alpha was used to analyze reliability of the instrument items within the constructs and the relationships among those constructs were explored using correlations. Descriptive statistics were also used to analyze the demographic responses, including the frequency and total percent response rate (Table 8).

Second, the researcher used SPSS Amos Version 24 to conduct Structural Equation Modeling (SEM) to test the model and hypotheses proposed by this study. SEM requires several steps for a thorough analysis and is being used more often in adoption studies (Fasteen, 2016; Kodjo, 2017). Data was organized and missing data was addressed (as noted above). The researcher also checked for outliers and lack of engagement using relatively simple tools and techniques in SPSS and Excel designed by James Gaskin (2016b). SPSS scatterplots were used to visually check for outliers and lack of engagement was checked by reviewing standard deviation data for each row of data in Excel (Gaskin, 2016b). The dataset for this study did not contain anything of concern in either of those regards. The dataset was also reviewed for skewness and kurtosis using frequency tables in SPSS and a technique that employs Excel for quick review (Gaskin, 2016b). No problems were located.

According to Schumaker and Lomax (2015), the first basic step to SEM is model specification. This step encompasses the development of a model based on theory and research. “Specification is the most important step,” (Kline, 2011, p. 93). It is the most important step because it defines the theoretical foundation and boundaries of the model being studied. Everything that comes after is bound by these parameters. In this study, a theoretical model (Figure 6) based on a combination of the constructs from DoI and TAM and proposed in previous research (Lee et al., 2011) was evaluated to see if the model was appropriate for the data sample collected for this study, fire service instructors.

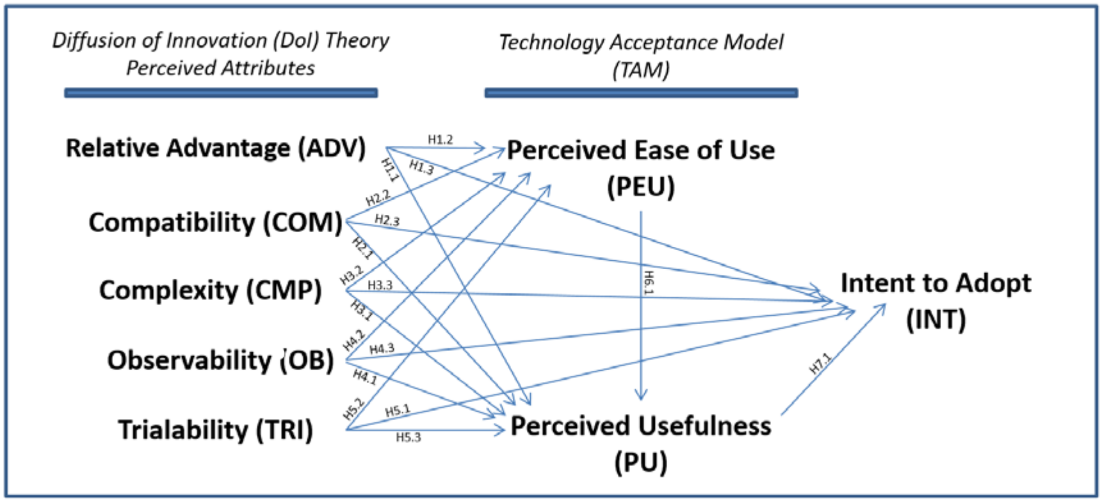


Figure 6. Conceptual Framework for Combining Diffusion of Innovation (DoI) Theory and the Technology Acceptance Model (TAM). Adapted from "Adding Innovation Diffusion Theory to the Technology Acceptance Model: Supporting Employees' Intentions to Use E-Learning Systems," by Y.-H. Lee, Y.-C. Hsieh, and C.-N. Hsu, 2011, *Educational Technology & Society, 14*, p. 129. Copyright © 2011 by Yi-Hsuan Lee, et al. Adapted with permission.

Once the model's theoretical foundations were identified, the researcher performed exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). According to Kline (2011), EFA is not really considered a step in SEM. EFA tests unrestricted models, which means researchers do not have to have a priori hypotheses identified to conduct an EFA. However, because this study used survey items from another study modified for a different sample and type of technology, performing a EFA first is common practice.

The EFA was conducted in SPSS using parallel axis factoring (PAF) and Promax rotation. For this study, communalities produced in the SPSS output report were reviewed for possible item deletion. Communality is the extent one item correlates to all of the other items in the study. Communalities of .40 to .70 were preferred, as is the case in most social science studies (Gaskin, 2016b). Items with communalities of less than .40 suggest weak relationships and may indicate that the item may not load significantly on any one factor during EFA. The communalities were satisfactory in this study. For factor loadings, .32 or higher were desirable for this study (Costello & Osborne, 2005). PAF was chosen over other options like principal components analysis (PCA) because it is one of the most widely used methods in factor analysis and is more commonly reported in social and behavioral science research. There are also some who argue that PCA is not a true factor analysis, but simply a data reduction method. One of the advantages of this method over principal components analysis (PCA), is that PAF considers only the common variance and seeks the least number of factors that can account for it (Gaskin, 2016e). Additionally, the data in this study was expected to be highly correlated and PAF is said to provide the best results in those situations (Costello & Osborne, 2005). Promax rotation was selected because it is an oblique rotation method. Promax is commonly used in social science research, is ideal for large datasets, and is used in studies where factors are expected to be highly correlated, as they were in this one (Costello & Osborne, 2005; Gaskin, 2016e).

To determine how many factors to retain for this study, the results of the above EFA steps and a parallel analysis (PA) were compared. PA is a Monte Carlo simulation technique that is considered by some to be a more accurate way to extract factors (Cokluk & Kocak, 2016; Horn, 1965; Ledesma & Valero-Mora, 2007; Wood, Gnonhosou, & Bowling, 2015). This method compares the eigenvalues from the dataset in the study to a random, simulated dataset to see if any of the factors occur by chance. Eigenvalues from the original data that are higher than the simulation values at the 95th percentile are typically the factors retained (Ledesma & Valero-Mora, 2007; Wood, et al., 2015). After reviewing the scree plot, eigenvalue information and comparisons, and communalities and factor loadings of the EFA process, the factors identified were tested for goodness of fit using CFA (Schumaker & Lomax, 2016).

Once the EFA was concluded, the researcher performed a CFA to test the relationships between and among the variables. Results of CFAs are conveyed through fit indices. While there were numerous opinions available in literature about which fit indices to report for CFA, they all agreed that offering numerous fit indices of different types was best practice (Kenny, 2015; Kline, 2011; Schumaker & Lomax, 2016). The different types of fit indices include absolute fit (how close to perfect the model is: RMSEA, SRMR), relative fit (compares the hypothesized model to the null model: NNFI), parsimonious fit (relative fit: NNFI), and noncentrality-based fit (chi-square that tests the null hypothesis). The fit indices and corresponding criteria for good fit chosen for this study are listed in Table 9.

Table 9

Fit Indices Used in this Study

Fit Index	Criteria for Good Fit
Chi-square	$p > .05$
Goodness of fit (GFI)	$p > .90$
Adjusted goodness of fit (AGFI)	$p > .90$
Root-mean-square error of approximation (RMSEA)	$p < .08$
Tucker-Lewis index (NNFI)	$p > .90$
Standardized RMR (SRMR)	$p < .10$

Model modification is the final step in the SEM process. This process included the factors retained in the EFA process and confirmed in CFA. Because the EFA uncovered information that differed from the originally proposed model, the researcher proposed an alternative model, still based on theoretical foundations, in order to find a superior model for the data collected. Review of the relationship between constructs were examined for their strengths and weaknesses. The mediating effects of constructs were tested to see if they improved the fit of the models as well. Two alternative models were developed and compared. All modifications were based on the underlying theory used in this study, which ensured better fit between the data and the model (Schumaker & Lomax, 2016).

Ethical Considerations

Ethical issues can arise at every phase of a research project (Creswell & Creswell, 2018). The protection of respondents falls under the purview of the researcher, as well as guarding against misconduct and maintaining the integrity of the research project.

Ethical issues identified prior to this study included safety of the participants, cooperation with a professional organization, and permission to conduct the study. The questions in the survey for this study were written and reviewed so that they did not present any personal or professional threats to the respondents. The researcher wanted to ensure the respondents were comfortable answering the questions honestly without fear of repercussions from their employers. The researcher sought and received cooperation from Fire Protection Publications at Oklahoma State University. This cooperation was necessary in order to receive a viable list of people who met the sampling criteria for the study. The researcher additionally sought and received approval from the Institutional Review Board (IRB) at Oklahoma State University to conduct the study.

Issues identified at the beginning of the study and as data was collected included consent, respect for the potential respondents' time, equal treatment, and ensuring the respondents were not identifiable. Each potential respondent was provided with an invitation to participate that included an information sheet and the informed consent language required by the IRB. All participants were informed that their participation was voluntary and that they could opt-out of participation. The potential recipients were contacted via e-mail to reduce the demand on their time and everyone received the same treatment and messages. The survey instrument did not require for any personally identifiable information.

During the analysis and reporting stages, the researcher avoided ethical issues regarding plagiarism by obtaining proper permissions for reprints and adaptations and using proper citations. The researcher developed a data and materials retention plan that ensures the information for the study will be stored for five years. An audit trail was designed and used to track all of the information for the study.

Summary

This chapter describes the methods used in this study including the research design, population information, instrumentation, procedures and timelines, data collection and analysis, and ethical considerations in this study in such a way that it could be repeated by other researchers using different populations and innovations.

CHAPTER IV

FINDINGS

This chapter details the results of the methods described in Chapter III and how they address the research questions and proposed structural model and hypotheses in this study. It includes descriptive statistics for the observed variables and the constructs, and the fit testing and model modifications conducted with SEM.

Results of Research Questions

The instrument used in this study asked fire service instructors to rate their level of agreement with statements about each of the theoretical constructs of DoI and TAM on five-point Likert-type scales. Table 10 lists the individual survey items, the number and percentage of responses for each one, and the means and standard deviations for each. The data in Table 10 indicates a level of agreement with most of the statements presented about the constructs taken from literature (Agarwal & Prasad, 1999; Hardgrave et al., 2003; Lee et al., 2011; Wu & Wang, 2005) and allowed analysis of each of the following research questions:

RQ1: Is the relative advantage of LMS technology correlated with the intent to adopt LMS technology?

RQ2: Is the compatibility of LMS technology correlated with the intent to adopt LMS technology?

RQ3: Is complexity of LMS technology correlated to the intent to adopt LMS technology?

RQ4: Is observability of LMS technology correlated to the intent to adopt LMS technology?

RQ5: Is trialability of LMS technology correlated to the intent to adopt LMS technology?

RQ6: Is perceived ease of use of LMS technology correlated the perceived usefulness of LMS technology?

RQ7: Is perceived usefulness of LMS technology correlated with the intent to adopt LMS technology?

Table 10

Responses, Means, and Standard Deviation for DoI and TAM Instrument Items (n=357)

Question		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total (*n* = 357)	*M*	*SD*
I think that using LMS technology fits well/will fit well with the way I like to work. (COM1)	*n* *%*	4 1.1	15 4.2	38 10.6	**207** **58**	93 26.1	357 100	4.04	.798
Using LMS technology fits/will fit into my work style. (COM2)	*n* *%*	4 1.1	17 4.8	46 12.9	**203** **56.9**	87 24.4	357 100	3.99	.816
Using LMS technology is appropriate for my teaching style. (COM3)	*n* *%*	7 2	26 7.3	59 16.5	**184** **51.5**	81 22.7	357 100	3.86	.918

Using LMS technology is compatible with most of my teaching. (COM3)	*n* *%*	8 2.2	29 8.1	69 19.3	**193** **54.1**	58 16.2	357 100	3.74	.904
Learning LMS technology was/will be easy for me. (CMP1)	*n* *%*	1 .3	32 9	71 19.9	**196** **54.9**	57 16	357 100	3.77	.832
I think LMS technology is clear and understandable. (CMP2)	*n* *%*	5 1.4	36 10.1	89 24.9	**191** **53.5**	36 10.1	357 100	3.61	.853
I think LMS technology is/will be easy to use. (CMP3)	*n* *%*	3 .8	26 7.3	92 25.8	**197** **55.2**	39 10.9	357 100	3.68	.796
Using LMS technology enables/will enable me to accomplish tasks more quickly. (ADV1)	*n* *%*	4 1.1	24 6.7	89 24.9	**178** **49.9**	62 17.4	357 100	3.76	.858
Using LMS technology improves/will improve the quality of the work I do. (ADV2)	*n* *%*	5 1.4	32 9	123 34.5	**158** **44.3**	39 10.9	357 100	3.54	.856
Using LMS technology makes it/will make it easier to do my job. (ADV3)	*n* *%*	8 2.2	21 5.9	101 28.3	**158** **44.3**	69 19.3	357 100	3.73	.917
Using LMS technology enhances/will enhance my effectiveness on the job. (ADV4)	*n* *%*	6 1.7	28 7.8	94 26.3	**169** **47.3**	60 16.8	357 100	3.70	.898

Using LMS technology increases/will increase my productivity. (ADV5)	*n* %	9 2.5	24 6.7	106 29.7	**160** **44.8**	58 16.2	357 100	3.66	.916
Before deciding on whether or not to use LMS technology, I saw a lot of others in my field using LMS technology. (OB1)	*n* %	19 5.3	**121** **33.9**	101 28.3	100 28	16 4.5	357 100	2.92	1.004
Before deciding on whether or not to use LMS technology, I saw demonstrations of LMS technology. (OB2)	*n* %	21 5.9	92 25.8	48 13.4	**157** **44**	39 10.9	357 100	3.28	1.137
Before deciding on whether or not to use LMS technology, I did not see many people using LMS technology. (OB3)	*n* %	24 6.7	**133** **37.3**	103 28.9	86 24.1	11 3.1	357 100	2.80	.983
Before deciding on whether or not to use LMS technology, I was permitted to use it long enough to see what it could do. (TRI1)	*n* %	15 4.2	89 24.9	71 19.9	**146** **40.9**	36 10.1	357 100	3.28	1.075
Before deciding on whether or not to use LMS technology, I was able to try its various options. (TRI2)	*n* %	18 5	98 27.5	68 19	**138** **38.7**	35 9.8	357 100	3.21	1.102

Before deciding on whether or not to use LMS technology, I already had a task in mind to test it. (TRI3)	*n* %	15 4.2	72 20.2	69 19.3	**142** **39.8**	59 16.5	357 100	3.44	1.11 2
I think that using LMS technology fits well/will fit well with the way I like to work. (PU1)	*n* %	6 1.7	32 9	76 21.3	**188** **52.7**	55 15.4	357 100	3.71	.892
Using LMS technology fits/will fit into my work style. (PU2)	*n* %	12 3.4	47 13.2	96 26.9	**158** **44.3**	44 12.3	357 100	3.49	.982
Using LMS technology is appropriate for my teaching style. (PU3)	*n* %	10 2.8	28 7.8	72 20.2	**177** **49.6**	70 19.6	357 100	3.75	.952
Using LMS technology is compatible with most of my teaching. (PEU1)	*n* %	5 1.4	34 9.5	94 26.3	**190** **53.2**	34 9.5	357 100	3.60	.841
Learning LMS technology was/will be easy for me. (PEU2)	*n* %	4 1.1	33 9.2	104 29.1	**185** **51.8**	31 8.7	357 100	3.58	.820
I think LMS technology is clear and understandable. (PEU3)	*n* %	11 3.1	48 13.4	110 30.8	**159** **44.5**	29 8.1	357 100	3.41	.928
I think LMS technology is/will be easy to use. (INT1)	*n* %	3 .8	13 3.6	55 15.4	**166** **46.5**	120 33.6	357 100	4.08	.840

Using LMS technology enables/will enable me to accomplish tasks more quickly. (INT2)	*n* *%*	17 4.8	70 19.6	86 24.1	**138** **38.7**	46 12.9	357 100	3.35	1.08
Using LMS technology improves/will improve the quality of the work I do. (INT3)	*n* *%*	6 1.7	8 2.2	46 12.9	**214** **59.9**	83 23.2	357 100	4.01	.777

Before addressing the individual research questions, the researcher conducted a reliability analysis on each of the constructs using Cronbach's Alpha, which tests internal consistency. The reliability coefficient considered acceptable in most social science research is .70 and anything less than .50 is considered unacceptable (Green & Salkind, 2011; Salkind, 2011). This initial analysis provided a brief look at the reliability of the items included in the study and items that could have caused problems in later analyses like exploratory factor analysis (EFA) and structural equation modeling (SEM). The item-total Cronbach's scores were reviewed using an option in SPSS that told the researcher what the scores would change to if individual survey items were deleted from the construct. If an individual item's deletion increased the score for the construct, it was deleted from further study. This method resulted in the removal of four items, OB2, TRI3, PEU3, and INT2 (Table 11).

Table 11

Comparison of Means, Standard Deviations, and Internal Consistency of Constructs

	Before Deletions				After Deletions			
Construct	Number of Items	Alpha (α)	*M*	*SD*	Number of Items	Alpha (α)	*M*	*SD*
Compatibility	4	.927	3.905	.7794	4	.927	3.905	.7794
Complexity	3	.894	3.688	.7526	3	.894	3.688	.7526
Relative Advantage	5	.899	3.676	.7504	5	.899	3.676	.7502
Observability	3	.594	3.137	.5660	2	.621	2.960	.8463
Trialability	3	.846	3.309	.9589	2	.878	3.242	1.0281
Perceived Ease of Use	3	.881	3.652	.8599	2	.904	3.658	.8599
Perceived Usefulness	3	.899	3.528	.7769	3	.899	3.588	.7932
Intent	3	.755	3.816	.7468	2	.837	3.719	.8167

Correlation coefficients were computed among the amended constructs in the study. The results of the correlational analysis in Table 12 indicated that all correlations were positive and 24 of the 28 correlations were statistically significant. All four of the statistically insignificant correlations included the observability (OB) construct. According to Rumsey (2018), correlation coefficients above .30 show a weak positive relationship, correlation coefficients above .50 indicate a moderate positive relationship, and .70 indicate a strong positive relationship. Within the OB relationships that showed any level of significance, OB←→INT showed a very weak linear relationship at .121 and OB←→PU showed a very weak correlation at .114. The strongest correlations overall were CMP←→PEU at .770; ADV←→PU at .736; and COM←→ADV at .709 as seen in Table 12 and in the scatterplot matric in Figure 7.

Table 12

Correlation Matrix of DoI and TAM Constructs

	INT	OB	TRI	PEU	PU	ADV	CMP	COM
INT	1							
OB	.121*	1						
TRI	.341**	.148**	1					
PEU	.432**	.086	.363**	1				
PU	.481**	.114*	.294**	.495**	1			
ADV	.495**	.060	.347**	.541**	.736**	1		
CMP	.366**	.030	.327**	.770**	.456**	.523**	1	
COM	.509**	.006	.278**	.498**	.670**	.709**	.509**	1

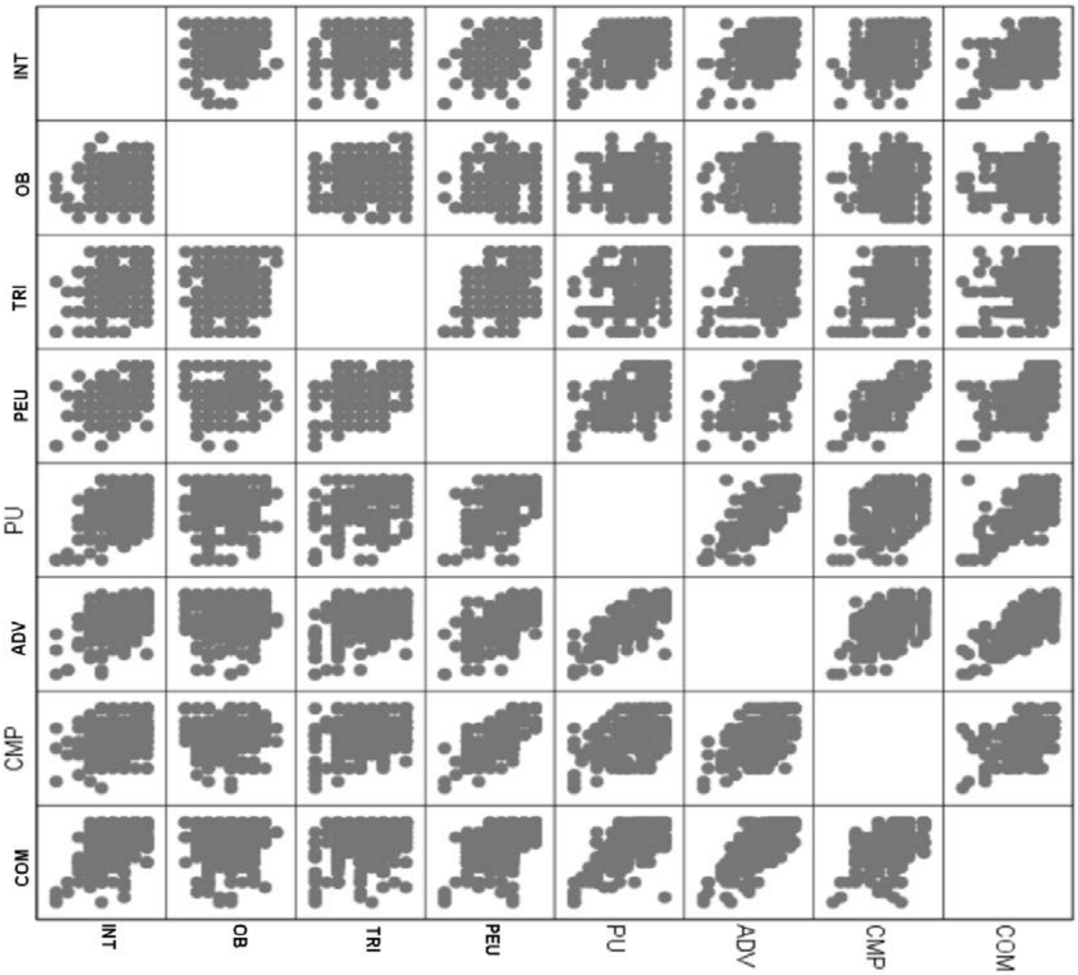


Figure 7. Scatterplot Matrix Depicted the Correlations Among the Constructs in this Study.

Research Question 1

Is the relative advantage of LMS technology correlated with the intent to adopt LMS technology?

Relative advantage (ADV) is defined as “the degree to which an innovation is perceived as being better than the idea it supersedes” (Rogers, 2003, p. 229). It is considered one of the best predictors for adoption and typically shows a positive relationship with intent to adopt (Lee et al., 2011; Rogers, 2003). Most of the responses to the items in this construct were positive (Table 10) with mean scores ranging from 3.54 to 3.76. The correlation coefficient for the ADV←→INT relationship was .495, *p* = .000, which indicated a moderately positive relationship, as seen in Figure 7.

Research Question 2

Is the compatibility of LMS technology correlated with the intent to adopt LMS technology?

Rogers (2003) defines compatibility (COM) as "the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters" (Rogers, 2003, p. 240). Compatibility is typically positively related to the rate of adoption. Most of the responses to the items in this construct were positive (Table 10) with mean scores ranging from 3.74 to 4.04. Literature does not necessarily highlight this construct as one of the best predictors for adoption. The correlation coefficient for the COM←→INT relationship was .509, *p* = .000, which indicated a moderately positive relationship, as seen in Figure 7.

Research Question 3

Is complexity of LMS technology correlated to the intent to adopt LMS technology?

Complexity (CMP) is defined as "the degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers, 2003, p. 257). If a potential adopter thinks the new innovation is too complicated to learn or use, they are less likely to adopt it. Most of the responses to the items in this construct were positive (Table 10) with mean scores ranging from 3.68 to 3.77, indicating that this sample of fire instructors did not view LMS as a particularly difficult technology to learn or use. This would normally result in a negative correlation. The survey questions were written in a way that suggests more ease of use of the LMS than complexity of the technology and could have impacted the responses. The correlation coefficient for the CMP←→INT relationship was .366, p = .000, which indicated a weak positive relationship, as seen in Figure 7.

Research Question 4

Is observability of LMS technology correlated to the intent to adopt LMS technology?

Rogers (2003) defines observability (OB) as "the degree to which the results of an innovation are visible to others" (Rogers, 2003, p. 258). This variable is also positively related to the rate of adoption. Most of the responses to the items in this construct indicated disagreement (Table 10) with mean scores ranging from 2.8 to 3.28. The correlation coefficient for the OB←→INT relationship was .121, p = .023, which indicated a very weak positive relationship, as seen in Figure 7.

Research Question 5

Is trialability of LMS technology correlated to the intent to adopt LMS technology?

Trialability is defined as "the degree to which an innovation may be experimented with on a limited basis" (Rogers, 2003, p. 258). This is simply "try it before you buy it" and is therefore positively related to the rate of adoption. Most of the responses to the items in this construct were positive (Table 10) with mean scores ranging from 3.21 to 3.44. The correlation coefficient for the TRI←→INT relationship was .341, *p* = .000, which indicated a weak positive relationship, as seen in Figure 7.

Research Question 6

Is perceived ease of use of LMS technology correlated the perceived usefulness of LMS technology?

Perceived ease of use (PEU) is the "degree to which an individual believes that using a particular system would be free of physical and mental effort" (Davis, 1986, p. 26). According to theory, ease of use has a direct, positive impact on perceived usefulness. Most of the responses to the items in this construct were positive (Table 10) with mean scores ranging from 3.41 to 3.6. The correlation coefficient for the PEU←→PU relationship was .495, *p* = .000, which indicated a moderate positive relationship, as seen in Figure 7.

Research Question 7

Is perceived usefulness of LMS technology correlated with the intent to adopt LMS technology?

Perceived usefulness (PU) is the "degree to which an individual believes that using a particular system would enhance his or her job performance" (Davis, 1986, p. 26). Usefulness does not have a direct impact on perceived ease of use, but it does ultimately influence intention to adopt and actual use an innovation. Most of the responses to the items in this construct were positive (Table 10) with mean scores ranging from 3.4 to 3.75. The correlation coefficient for the PU←→INT relationship was .481, *p* = .000, which indicated a weak positive relationship, as seen in Figure 7.

Overall, the results of the analysis in this study were consistent with the information collected from existing literature and theory.

Model Fit and Hypothesis Testing with Structural Equation Modeling

Research Question 8

Does the proposed research model align with theoretical hypotheses as they apply to fire service instructors?

Exploratory Factor Analysis. The EFA conducted in SPSS Version 25 utilized principal axis factoring, Promax rotation, and no restrictions on the number of factors (Green & Salkind, 2011; Yong & Pearce, 2013) and identified five factors. The scree plot, depicted in Figure 8, is another piece of EFA evidence that shows the five factors with eigenvalues above 1 retained after the EFA. Several iterations of the EFA were conducted to determine the viability of the factors. Early iterations, revealed two sets of factors loaded together: ADV with PU and CMP with PEU.

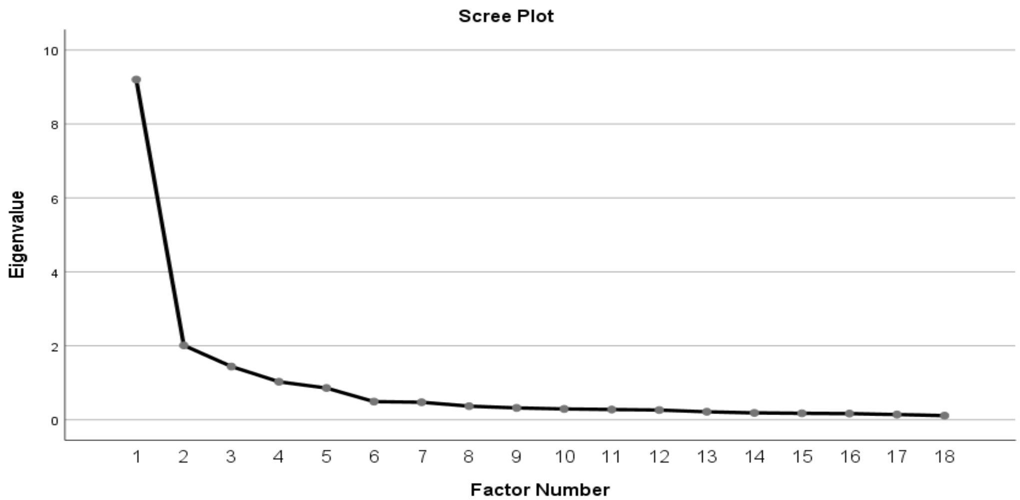


Figure 8. Screen Plot from EFA Analysis Showing Five-Factor Extraction.

Parallel Analysis (Horn, 1965), a secondary analysis, was conducted via SPSS Version 25 using a syntax script developed by B.P. O'Connor (2000) to explore how many factors should be extracted from the data. The theoretical model for the study proposed eight factors (COM, CMP, ADV, OB, TRI, PEU, PU, and INT). The parallel analysis clearly identified four factors and a fifth factor in which the difference between the simulation and original data was only .118. The researcher chose to retain the fifth factor for the study (Table 13).

Table 13

Parallel Analysis Results

Factor	Eigenvalue from Dataset	Mean Eigenvalue from Monte Carlo	95th Percentile Eigenvalue from Monte Carlo
1	11.437	1.544	1.622
2	2.531	1.462	1.520
3	2.066	1.400	1.449
4	1.393	1.348	1.390
5	1.223*	1.301	1.341*
6	.968	1.259	1.299
7	.876	1.217	1.252
8	.675	1.178	1.207
9	.580	1.142	1.173
10	.575	1.108	1.140
11	.500	1.074	1.103
12	.446	1.040	1.070
13	.409	1.009	1.037
14	.382	.978	1.007
15	.361	.978	.975
16	.320	.947	.942
17	.301	.917	.913
18	.277	.887	.885
19	.268	.858	.856
20	.258	.828	.825
21	.240	.769	.796
22	.194	.738	.765
23	.178	.708	.739
24	.166	.677	.709
25	.139	.643	.674
26	.134	.607	.640
27	.104	.563	.602

*The difference in the fifth factor is .118. The researcher chose to retain this factor.

Based on results of the EFA and parallel analysis conducted, the researcher removed one construct, OB. This decision was a result of several items found during analysis. First, OB2 was removed, as noted earlier, because the deletion of the item made the construct stronger. When factoring the remaining two OB items in the model, the communalities for them were significantly lower than the rest at OB1 = .328 and OB3 = .279. All other construct items were above .60. Additionally, the factor loadings in the EFA for the remaining two items were also low compared to other items at .308 and .320, respectively. The OB construct had either statistically insignificant relationships: OB←→PEU at .086, OB←→ADV at .060, OB←→CMP at .030, and OB←→COM at .006 or very weak positive correlations: OB←→INT at .121, OB←→TRI at .148, OB←→PU at .114, with all of the other constructs in the study. Theoretically, this is not unusual for this particular construct. Moore and Benbasat (1991) noted that this construct was more complex than it appeared because the definition of the construct could be interpreted in different ways. The original definition referred to the visibility of the results of using an innovation and whether or not these results were communicable to other people (Rogers, 2003). Over time, the definition shrunk to just visibility of the innovation, regardless of results. The researcher made the decision to remove the construct as a result of the analysis specified above and because the model with these two items included only explained 68% of the variance with 10% non-redundant residuals. Non-redundant residuals need to be as low as possible and percentages above 3% are not recommended (Gaskin, 2016b). Removing the construct resulted in an increase of explained variance to 73% and reduced the non-redundant residuals to 3%. In addition to improving the overall model, the removal also resulted in one item, ADV2, cross-loading on the PU construct.

Because CFA and ultimately SEM, are theory-driven, decisions were made not only in consideration to the results of the analysis, but also in consideration of the theory related to the constructs in order to ensure the theoretical integrity of the research remained intact. This informed many of the following decisions made during EFA, as well as the knowledge that many of the constructs in DoI and TAM are similar and overlap (Carter & Belanger, 2005; Moore & Benbasat, 1991).

In 1991, Moore and Benbasat conducted an extensive study to identify reliable measures for DoI. They used a number of judges and sorting rounds and found that it was not unusual for certain constructs to load on the same factor (Rogers, 2003; Carter & Belanger, 2005; Moore & Benbasat, 1991). For example, in their research, ADV, COM, and PU were identified as separate by the judges and in the sorting rounds. However, when tested, the constructs loaded on the same factor. Moore and Benbasat concluded that the conceptual difference between the constructs were not obvious to the respondents in their study or that a causal relationship existed between the constructs (Moore & Benbasat, 1991).

In this study, ADV and PU initially loaded on the same factor as well. Because ADV had five items, the researcher used the "when deleted" information outlined previously to see which item's removal would strengthen the overall construct. The researcher decided to remove ADV2 and explore the result. The removal of ADV2 separated ADV and PU into two distinct factors, so further exploration was deemed unnecessary.

The constructs of CMP and PEU also loaded on one factor in this study. A review of the Cronbach's alpha for these two items combined into one construct was very strong at $\alpha = .922$. To explore whether or not this information would lead to a better model, the researcher conducted an additional EFA with CMP and PEU exclusively and only one factor was identified. As a result, the researcher chose to combine the items and create one construct under CMPPEU. Theoretically, these two constructs are often compared to one another (Davis et al., 1989; Lee et al., 2011; Rogers, 2003) and combining them into one construct maintained the theoretical integrity of the model. In addition to the literature support for this decision, the correlation between CMP and PEU was the strongest in the study at .770.

The KMO for the final EFA was .915, $p < .05$. The minimum KMO value recommended is .5 and values above .9 are considered superb (Hadi et al., 2016). All of the communalities were above .3, which is the desired level (Gaskin, 2016b), the five-factor model explained 74% of the variance, and there were less than 3% non-redundant residuals. The pattern matrix showed convergent validity above the preferred level of .5 for all items except ADV4 and the discriminant validity showed no strong cross-loadings (Table 14).

Table 14

Final Exploratory Factor Analysis Results

	Factors				
	1	2	3	4	5
COM1		.929			
COM2		.921			
COM3		.829			
COM4		.721			
CMP1	.848				
CMP2	.862				
CMP3	.839				
ADV1				.741	
ADV3				.827	
ADV4				.422	
ADV5				.895	
TRI1					.910
TRI2					.868
PU1			.788		
PU2			.991		
PU3			.662		
PEU1	.843				
PEU2	.747				

Note. Extraction Method: Principal Axis Factoring. Rotation Method: Promax with Kaiser Normalization.[a]
a. Rotation converged in 6 iterations.

It should be noted that while it is ideal to have at least three indicator items for each factor, it is acceptable to use two if certain conditions are met. The first is that the errors for the two indicator variables are not correlated and the second is that errors on either of the two indicator items are not correlated with the error's on another factor's indicator items (Kline, 2011; Schumaker & Lomax, 2016). These were met for this study.

Confirmatory Factor Analysis (CFA). Once the EFA was completed, a CFA was conducted using the five factors identified during EFA: ADV, COM, TRI, CMPPEU, and PU. CFA is the first step in SEM and is conducted to check the fit of data collected with the model proposed. The fit indices included in this study were within recommended levels: GFI p = .92; AGFI p = .90; RMSEA p = .06; NNFI p = .95; and SRMR p = .04, and are included in Figure 9.

Table 15

Confirmatory Factor Analysis Factor Loadings, Item Reliability, Construct Reliability, Average Variance Extracted, and Fit Indices

Latent Variable	Observed Variable	Unstd. Factor Loading	Std. Error	Item Reliability (R^2)
Compatibility (COM)	COM1	1.10***	.0581	18.913
	COM2	1.12***	.0594	18.859
	COM3	1.13***	.0526	21.499
	COM4	1.00	N/A	N/A
Relative Advantage (ADV)	ADV1	.8979***	.0502	17.895
	ADV3	.9827***	.0512	19.206
	ADV4	.9488***	.0513	18.141
	ADV5	1.00	N/A	N/A
Trialability (TRI)	TRI1	.9871***	.0914	10.798
	TRI2	1.00	N/A	N/A
Complexity/Perceived Ease of Use	CMP1	1.00	N/A	N/A
	CMP2	1.114***	.0587	19.969
	CMP3	1.073***	.0543	19.753
	PEU1	.9731***	.0604	16.102
	PEU2	.9629***	.0586	16.432
Perceived Usefulness (PU)	PU1	.9409***	.0422	22.319
	PU2	1.00	N/A	N/A
	PU3	.9316***	.0468	19.891

Index	Measurement Model Level
df	122
x^2	280.8107***
GFI	.92
AGFI	.90
SRMR	.04
RMSEA	.06
NNFI	.95

Reliability as well as convergent and discriminant validity are shown in Table 16 (Gaskin, 2106d), which shows reliability confirmed with composite reliability (CR) of all items above .7. Convergent validity was evidenced by all average variance extracted (AVE) items above .5. Discriminate validity was based on the square root of the AVE being greater than any inter-factor correlation in the matrix and is shown in Table 16 with the square root of the AVE on the diagonal in bold and then the correlations for the constructs below them.

Table 16

Composite Reliability, Average Variance Extracted, Maximum Squared Variance, and Correlations

	CR	AVE	MSV	TRI	COM	ADV	CMPPEU	PU
TRI	0.878	0.783	0.155	**0.885**				
COM	0.924	0.754	0.553	0.319	**0.868**			
ADV	0.894	0.679	0.606	0.386	0.744	**0.824**		
CMPPEU	0.916	0.686	0.366	0.393	0.561	0.605	**0.828**	
PU	0.901	0.752	0.606	0.335	0.691	0.778	0.543	**0.867**

Note. CR = Composite Reliability (p > .7); AVE = Average Variance Extracted (p > .5); MSV = Maximum Squared Variance (MSV<AVE) (Gaskin, 2016a, 2016d).

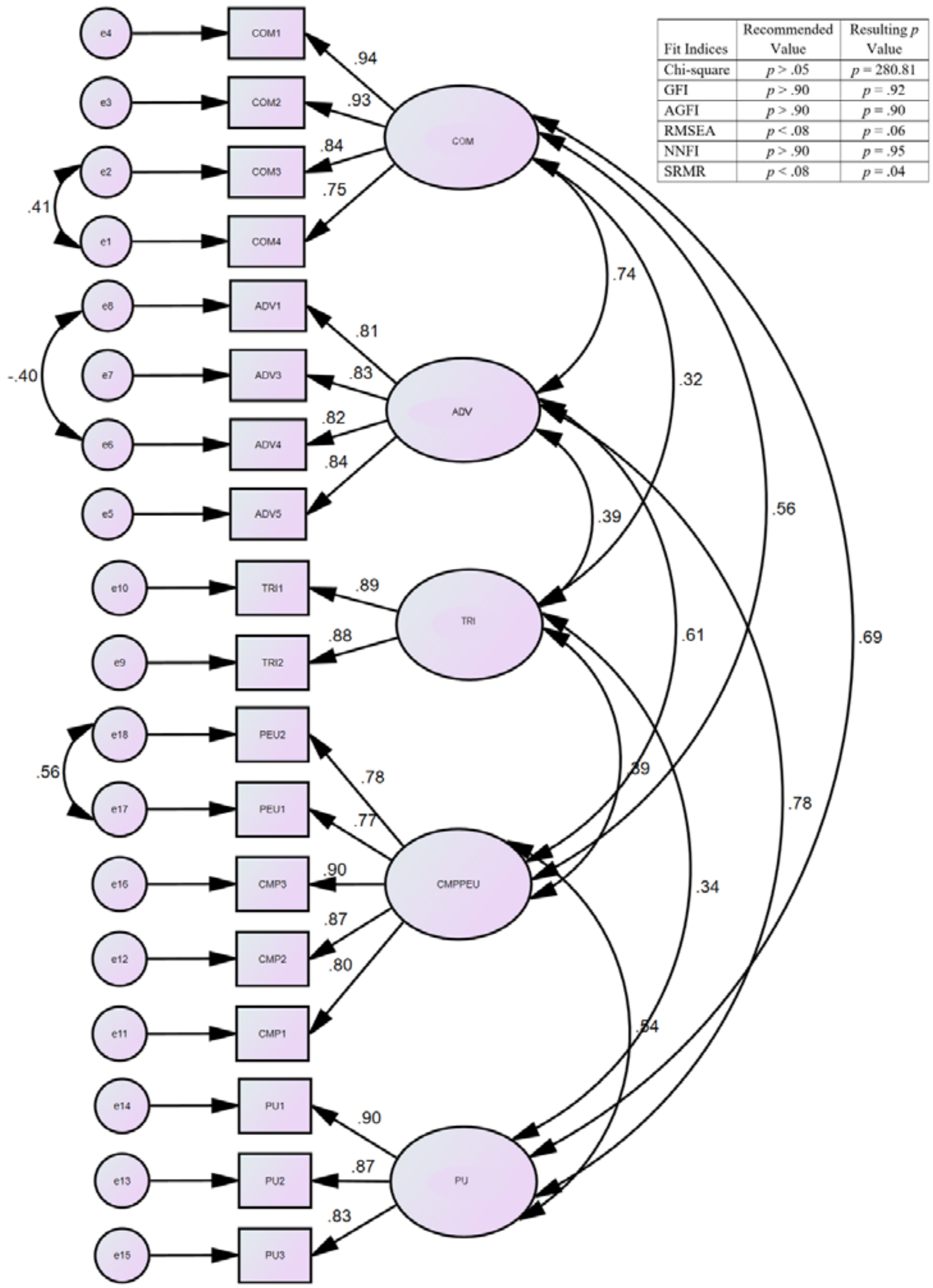


Figure 9. Confirmatory Factor Analysis Results and Fit Indices. GFI = goodness-of-fit index; AGFI = adjusted goodness-of-fit index; RMSEA = root mean square error of approximation; NNFI = non-normed fit index; and SRMR = standardized root mean square residual.

First Alternative Model. The CFA analysis made it clear that a five-factor model was viable for SEM, which differed from the original eight-factor model proposed in Figure 6. Because EFA analyses conducted resulted in the elimination of a factor, OB, and the combination of the complexity (CMP) and perceived ease of use (PEU) constructs, the researcher hypothesized and tested an alternative model (Figure10).

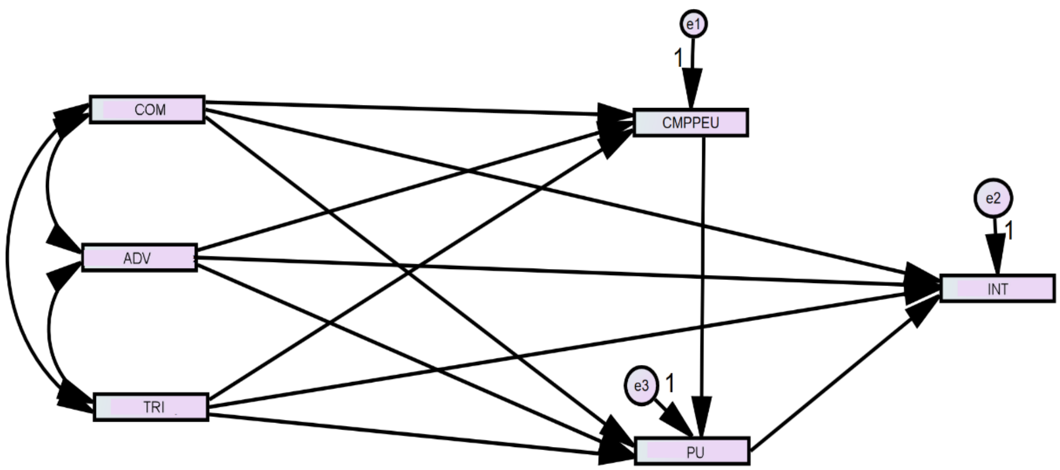
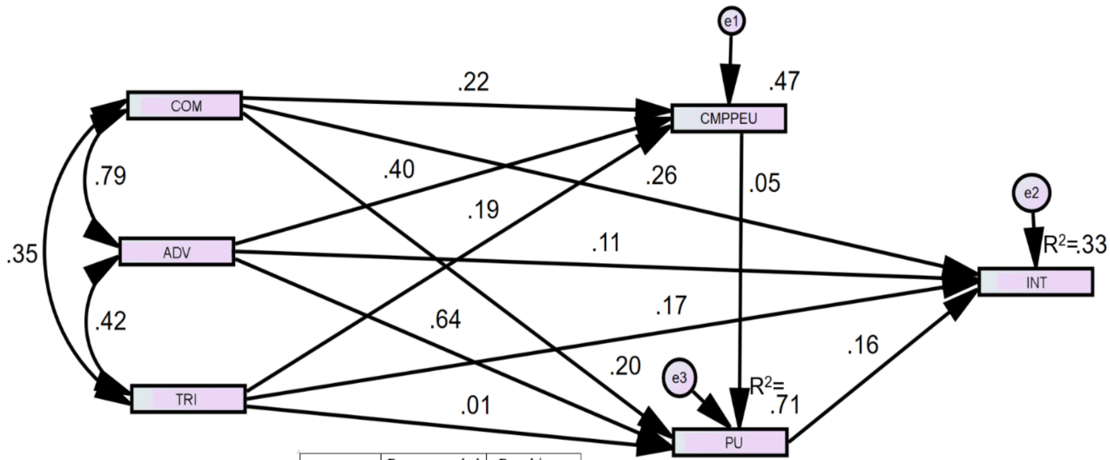


Figure 10. First Alternative Structural Model.

"The goal of SEM is to achieve the best model fit without compromising the theory being represented" (Cribbs, Hazari, Sonnert & Sadler, 2015, p. 8). This first alternative model still held theoretical integrity, just with fewer constructs for DoI as discussed in the EFA results. It is not unusual for different pieces of DoI theory to be used in research (Burrough, 2015; Lee et al., 2011; MacVaugh & Schiavone, 2010;

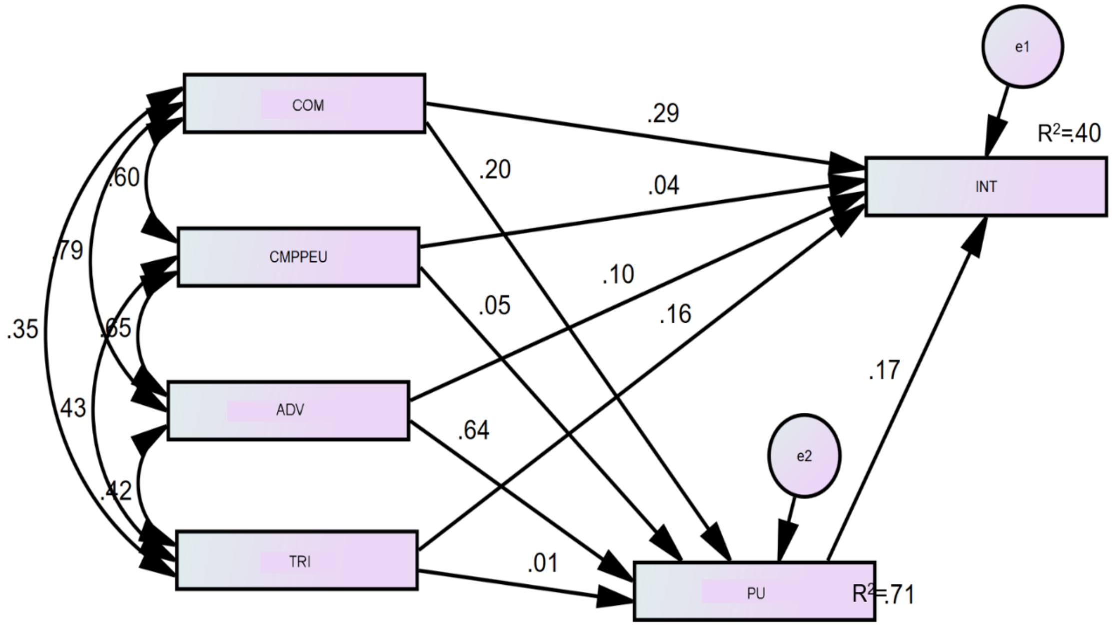
Miller & Bull, 2013; Reggi et al., 2003; Rogers et al., 2009; Ryan & Gross, 1943). This first alternative model placed the new construct CMPPEU in the original PEU position of the TAM. TAM theory states that PEU has a direct effect on PU and that PU acts as a mediator between PEU and INT. In the combined theories of DoI and TAM, PEU was also used as a mediating factor between all of the characteristics of the innovation and INT (Davis, 1986; Davis, 1989; Lee et al., 2011; Rogers, 2003). This position in the first alternative model placed the construct in a position to mediate DoI factors through PU before INT. The results, based on standardized values, can be seen in Figure 10. While the fit indices were acceptable, the negligible relationship of .05 between CMPPEU←→PU and .01 between TRI←→PU made it necessary to explore further. The researcher modified the model by removing the path between TRI and PU, which was even more negligible at .01, to see if it improved the model fit. The researcher also reviewed the mediation effect of PU on CMPPEU and INT and it was insignificant at $p < .2241$.



Fit Indices	Recommended Value	Resulting *p* Value
Chi-square	$p > .05$	$p = .6$
GFI	$p > .90$	$p = .9994$
AGFI	$p > .90$	$p = .9874$
RMSEA	$p < .08$	$p = .0000$
NNFI	$p > .90$	$p = .9995$
SRMR	$p < .08$	$p = .0055$

Figure 11. First Alternative Structural Model with Fit Indices.

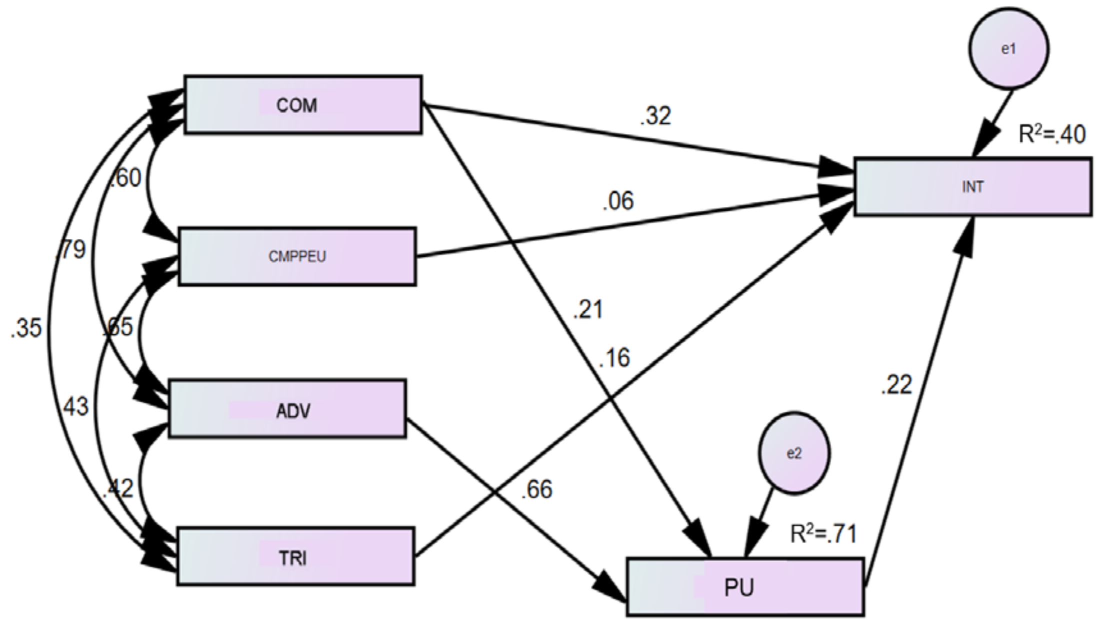
Second Alternative Model. The second alternative model placed the CMPPEU construct in the original CMP position of the DoI. This removed the new construct from its role as a mediator factor and made it one of the characteristics of the innovation. The researcher chose to do this to maintain theoretical integrity even though some of the analysis from the first alternative model would support removing the CMPPEU construct altogether. As Shumaker and Lomax (2016) state: "…model fit is the subjective approach that requires substantive theory because there is no single best model" (p. 247). The results, with standardized values, can be seen in Figure 12.



Fit Indices	Recommended Value	Resulting *p* Value
Chi-square	$p > .05$	$p = 0$
GFI	$p > .90$	$p = 1.0$
AGFI	$p > .90$	$p =$ --
RMSEA	$p < .08$	$p = .4848$
NNFI	$p > .90$	$p = 1.0$
SRMR	$p < .08$	$p = .0000$

Figure 12. Second Alternative Structural Model with Fit Indices.

Model fit for the second alternative model was not within acceptable parameters for the RMSEA fit index at .4848 and $\chi^2 = 0.0$. Fit indices improved when the paths were removed from TRI to PU, CMPPEU to PU, and ADV to INT. The paths for these items were weak at .01, .05, and .10, respectively, and insignificant at .7493, .2223, and .2314, respectively. The resulting model, with standardized values, and fit indices are in Figure 13. The result is the final model for this study.



Fit Indices	Recommended Value	Resulting *p* Value
Chi-square	*p* > .05	*p* = 3.3
GFI	*p* > .90	*p* = .9969
AGFI	*p* > .90	*p* = .9783
RMSEA	*p* < .08	*p* = .0165
NNFI	*p* > .90	*p* = .9974
SRMR	*p* < .08	*p* = .0087

Figure 13. Second Alternative Structural Model (amended) with Fit Indices. This is the final model for this study.

Table 17

Comparative Model Fit Scores

Fit Indices	Recommended Value	Alternative Model 1	Alternative Model 2	Final Model
Chi-square	*p* > .05	*p* = .6	*p* = 0	*p* = 3.3
GFI	*p* > .90	*p* = .9994	*p* = 1.0	*p* = .9969
AGFI	*p* > .90	*p* = .9874	*p* = --	*p* = .9783
RMSEA	*p* < .08	*p* = .0000	*p* = .4848	*p* = .0165
NNFI	*p* > .90	*p* = .9995	*p* = 1.0	*p* = .9974
SRMR	*p* < .08	*p* = .0055	*p* = .0000	*p* = .0087

The final model was used for further analysis and hypothesis testing. First, indirect effects were analyzed between COM-PU-INT and ADV-PU-INT. Results showed that perceived usefulness had a significant mediating effect between both COM-INT (p = .0034) and ADV-INT (p = .0051). The estimated effects were μ = .0538 and μ = .1476, respectively.

Table 18

Results of Structural Equation Modeling Analysis

Parameter	Unstandardized	Standardized	*p*
	Structural Coefficients		
ADV → PU	.72	.66	$p < .001$
COM → PU	.26	.21	$p < .001$
PU → INT	.20	.22	$p < .001$
TRI → INT	.13	.16	$p < .001$
COM → INT	.37	.32	$p < .001$
CMPPEU → INT	.07	.06	$p = .2884$
	PU Effects		
COM→PU→INT	.0538	.0538	--
ADV→PU→INT	.1476	.1476	--
	Factor Loadings		
Compatibility			
COM1	1.10	.94	$p < .001$
COM2	1.12	.93	$p < .001$
COM3	1.13	.84	$p < .001$
COM4	1.00	.75	$p < .001$
Relative Advantage			
ADV1	.90	.81	$p < .001$
ADV3	.98	.83	$p < .001$
ADV4	.95	.82	$p < .001$
ADV5	1.00	.84	$p < .001$
Trialability			
TRI1	.99	.89	$p < .001$
TRI2	1.00	.88	$p < .001$
Complexity/Perceived Ease of Use:			

CMPPEU			
PEU2	.96	.78	$p < .001$
PEU1	.97	.77	$p < .001$
CMP3	1.07	.90	$p < .001$
CMP2	1.11	.87	$p < .001$
CMP1	1.00	.80	$p < .001$
Perceived Usefulness			
PU1	.94	.90	$p < .001$
PU2	1.00	.87	$p < .001$
PU3	.93	.83	$p < .001$
	Measurement Error Variances		
e1 on COM4	.35	.35	$p < .001$
e2 on COM3	.25	.25	$p < .001$
e3 on COM2	.09	.09	$p < .001$
e4 on COM1	.08	.08	$p < .001$
e5 on ADV4	.24	.24	$p < .001$
e6 on ADV3	.27	.27	$p < .001$
e7 on ADV1	.26	.26	$p < .001$
e8 on TRI1	.25	.25	$p < .001$
e9 on CMP1	.27	.27	$p < .001$
e10 on CMP2	.24	.24	p = .0027
e11 on PU2	.25	.25	$p < .001$
e12 on PU1	.17	.17	$p < .001$
e13 on PU3	.24	.24	$p < .001$
e14 on CMP3	.15	.15	$p < .001$
e15 on PU3	.28	.28	$p < .001$
e16 on CMP3	.12	.12	$p < .001$
e17 on PEU1	.28	.28	$p < .001$
e18 on PEU2	.26	.26	$p < .001$
	Factor Variances		
COM	.46	.46	$p < .001$
ADV	.59	.59	$p < .001$
TRI	.94	.94	$p < .001$
CMPPEU	.44	.44	$p < .001$
PU	.74	.74	$p < .001$
	Error Covariance		
e1→e2	.12	.41	$p < .001$
e6→e8	-.10	-.40	$p < .001$
e17→e18	.15	.56	$p < .001$
	Factor Covariance		
COM←→ADV	.39	.39	$p < .001$
COM←→TRI	.21	.21	$p < .001$
ADV←→TRI	.29	.29	$p < .001$
COM←→CMPPEU	.25	.25	$p < .001$
COM←→PU	.40	.40	$p < .001$

ADV$\leftrightarrow$CMPPEU	.31	.31	$p < .001$
ADV$\leftrightarrow$PU	.51	.51	$p < .001$
TRI$\leftrightarrow$CMPPEU	.25	.25	$p < .001$
CMPPEU$\leftrightarrow$PU	.31	.31	$p < .001$
TRI$\leftrightarrow$PU	.28	.28	$p < .001$

Research Question 8

Does the proposed research model align with theoretical hypotheses as they apply to fire service instructors?

The research model first proposed in this study did not align with the theoretical hypotheses as they applied to this particular set of data. As a result, the researcher presented alternative structural models that offered a better explanation of the data collected. The results of the original proposed hypotheses are listed in Table 19.

Table 19

Hypothesis Testing Results Based on Structural Equation Modeling

Hypotheses	Path	Direction	Conclusion
$H1.1_0$; $H1.1_1$	ADV$\rightarrow$PU*	Positive	Reject $H1.1_0$; Supported
$H1.2_0$; $H1.2_1$	ADV$\rightarrow$PEU	--	Fail to reject $H1.2_0$; Not supported
$H1.3_0$; $H1.3_1$	ADV$\rightarrow$INT	--	Fail to reject $H1.3_0$; Not supported
$H2.1_0$; $H2.1_1$	COM$\rightarrow$PU*	Positive	Reject $H2.1_0$; Supported
$H2.2_0$; $H2.2_1$	COM$\rightarrow$PEU	--	Fail to reject $H2.2_0$; Not supported

$H2.3_0$; $H2.3_1$	COM→INT*	Positive	Reject $H2.3_0$; Supported
$H3.1_0$; $H3.1_1$	CMP→PU	--	Fail to reject $H3.1_0$; Not supported
$H3.2_0$; $H3.2_1$	CMP→PEU*	Positive	Reject $H3.2_0$; Supported
$H3.3_0$; $H3.3_1$	CMP→INT*	Positive	Reject $H3.3_0$; Supported
$H4.1_0$; $H4.1_1$	OB→PU	--	Fail to reject $H4.1_0$; Not supported
$H4.2_0$; $H4.2_1$	OB→PEU	--	Fail to reject $H4.2_0$; Not supported
$H4.3_0$; $H4.3_1$	OB→INT	--	Fail to reject $H4.3_0$; Not supported
$H5.1_0$; $H5.1_1$	TRI→PU	--	Fail to reject $H5.1_0$; Not supported
$H5.2_0$; $H5.2_1$	TRI→PEU	--	Fail to reject $H5.2_0$; Not supported
$H5.3_0$; $H5.3_1$	TRI→INT*	Positive	Reject $H5.3_0$; Supported
$H6.1_0$; $H6.1_1$	PEU→PU	--	Fail to reject $H6.1_0$; Not supported
$H7.1_0$; $H7.1_1$	PU→INT*	Positive	Reject $H7.1_0$; Supported

Note. Items marked with * are included in the final structural model.

Summary

The purpose of this chapter was to present the findings from this study. The researcher described the use of descriptive and multivariate statistical analysis to report the findings. Correlations analysis showed that all of the constructs in the study were positively correlated to the intent to adopt LMS. SEM analysis showed that the original model proposed was not the best fit for the data and resulted in the in the development and testing of an alternative model that showed best fit for this data set.

CHAPTER V

CONCLUSIONS

The purpose of this study was twofold. The first purpose was to explore the adoption and implementation of one type of educational technology, Learning Management Systems (LMS), by fire service instructors. This study explored the adoption of LMS by fire service instructors using well-established hypotheses related to diffusion of innovation theory (DoI) and the technology acceptance model (TAM). This study determined that the use of DoI and TAM can be used to determine adoption behavior in this population. However, this study also uncovered that it may be unnecessary to combine the two theories in order to obtain adoption information. This was discovered during the process used to address the second purpose of this study: model modification and fit testing in structural equation modeling to explore whether or not the proposed model applied to the data collected in this study. These items, as well as implications and recommendations, will be addressed in this chapter.

Research Question Conclusions

The simple correlations used in this study to explore the relationships between the constructs of DoI and TAM and the adoption of LMS technology provided affirmative answers to all of the following research questions:

RQ1: Is the relative advantage of LMS technology correlated with the intent to adopt LMS technology?

RQ2: Is the compatibility of LMS technology correlated with the intent to adopt LMS technology?

RQ3: Is complexity of LMS technology correlated to the intent to adopt LMS technology?

RQ4: Is observability of LMS technology correlated to the intent to adopt LMS technology?

RQ5: Is trialability of LMS technology correlated to the intent to adopt LMS technology?

RQ6: Is perceived ease of use of LMS technology correlated the perceived usefulness of LMS technology?

RQ7: Is perceived usefulness of LMS technology correlated with the intent to adopt LMS technology?

These answers indicated support for using DoI theory and TAM to study and predict which attributes of new innovations had the most influence with fire service instructors: compatibility, relative advantage, and perceived usefulness, respectively.

Compatibility

This DoI construct was the most correlated with the intent to adopt for this sample. This suggested that fire service instructors needed to perceive a new innovation as compatible with the way they already worked or that a new innovation will be compatible with the way they want to work in the future.

Relative Advantage

Literature indicates that this typically is the DoI construct that has the most significant relationship with intent to adopt (Lee et al., 2011; Rogers, 2003). Past research also indicates that relative advantage and compatibility are often seen as measuring the same information (Rogers, 2003; Carter, 2005; Moore & Benbasat, 1991). As mentioned in Chapter IV, these two constructs initially loaded on the same factor. This indicated to the researcher that this group of respondents perceived the compatibility of LMS and the relative advantages of the technology as almost the same thing. It additionally suggested that the survey items might not have been worded specifically enough to elicit exclusive responses for this construct.

Perceived Usefulness

This TAM construct is not that different from the two constructs already mentioned (Rogers, 2003; Carter & Belanger, 2005; Moore & Benbasat, 1991). The difference in this construct from the ones mentioned above was that this construct did not load well in the factor analysis. This indicated to the researcher that the survey items used made statements that were clear enough to differentiate this construct from the others.

Theoretical Alignment

While all of the correlations in this study were positive, there were additional findings worth noting. First, not all of the correlated relationships were consistent with theory. Typically, the construct of complexity in DoI is negatively related to adoption. In this study, there was a weak positive relationship between complexity and intent. A review of the survey item responses and demographic information indicated that 87% of the respondents already used LMS technology. This percentage explained their disagreement with responses to statements that indicated the use of LMS was difficult. As users who have already adopted, they either no longer viewed the technology as complex or they never did. Rogers (2003) pointed out that this is one of the limitations to DoI studies. Because innovations diffuse over time, it is sometimes difficult for people who adopted in the past to recall their motivations at the time of adoption. “Essentially, people are asked to look back in time in order to reconstruct their past history of innovation experiences” (Rogers, 2003, p 127). One way to mitigate this issue in future research would be to make sure the potential respondents understand that the reasons for not adopting an innovation are just as important as the reasons for adopting it. This should be clearly stated in the introduction of the survey to prevent respondents from assuming the survey is only interested in answers from current users or adopters and clicking delete.

Observability

The second interesting discovery was the near irrelevancy of the DoI construct observability. As mentioned briefly in Chapter IV, Moore and Benbasat (1991) described observability as a complex construct. They explained that the definition of the construct had been interpreted in different ways and had changed over time. The original definition referred to the visibility of the results of using an innovation and whether or not the results were communicable to other people (Rogers, 2003). Over time, the definition concentrated more on the visibility of the innovation, regardless of results. In addition to this, Rogers (2003) also indicated that software-dominant innovations are less observable than hardware innovations and usually have a slower rate of adoption than hardware. The LMS technology the respondents in this study had free access to was web-based software, so observing peers using the technology was limited. Another possible explanation for the irrelevancy of the observability construct in this study was the isolation of the respondents. Many fire service instructors work separate from their peers. Almost half of the respondents in this study were from local or volunteer departments. As mentioned in Chapter II, many fire service instructors are individual firefighters within a department assigned the additional duties of a training officer. Rogers refers to relationships among potential adoption populations as “diffusion networks” (Rogers, 2003, p. 300). Like the perceived attributes of innovations used in this study, “Nature of the Social System” (Rogers, 2003, p. 222) is one of the other variables in DoI that can be used to study the rate of adoption based on “how interpersonal communication drives the diffusion process by creating a critical mass of adopters” (Rogers, 2003, p. 222). The influence of peers is also reflected in Mary Douglas’ Grid and Group Cultural Theory, which describes how people are bonded together and how those bonds influence their norms, practices, and activities (Mamadouh, 1999). Future research could encompass the social system variable from DoI or some aspect of the grid and group cultural theory to see if the isolation of this discipline does impact the adoption of innovations.

Model Testing and Modifications Conclusions

Structural equation modeling (SEM) resulted in a model that fit the data gathered in this study. The result, however, was a model modified from the one first proposed.

> RQ8: Does the proposed research model align with theoretical hypotheses as they apply to fire service instructors?

The proposed structural model did not fit well with the data from this study and was modified as described in Chapters III and IV. The final model indicates it was not necessary to combine DoI and TAM to measure adoption in this population, as suggested in previous research (Bousbahi & Alrazgan, 2015; Carter & Belanger, 2005; Chen et al., 2002; Lee et al., 2011; Legris et al., 2003; Lim, 2009; Moore & Benbasat, 1991; Ward, 2013; Wong, 2014; Wu & Wang, 2005). While the two theories started in different topic areas, they have similarities (Carter & Belanger, 2005; Chen et al., 2002; Lee et al., 2011; Lim, 2009; Wu & Wang, 2005). For example, the complexity element from DoI is often compared to the perceived ease of use element of TAM, as was seen in this study and mentioned above. This overlap of the two constructs was so strong in this research, it resulted in the combination of the two constructs for the final model. Another indication that DoI and TAM did not need to be combined for this study was the lack of support for the direct influence of PEU on PU put forth in TAM theory (Davis, 1986). This was evident when the new construct of CMPPEU was placed in the structural model in the position theory dictated for PEU and the model fit was not acceptable. When moved to the position dictated for CMP in DoI theory, the direct relationship between CMPPEU and PU was so weak, the path was removed from the final accepted model. The final model suggests that compatibility and relative advantage have a strong relationship to the perceived usefulness of LMS technology. It also suggests that compatibility does not need to pass through the construct of perceived usefulness to lead to adoption. The relationship between compatibility and intent was stronger alone than when compatibility passed through the perceived usefulness construct. The final model also suggests that perceived ease of use and complexity do not have much of a relationship with intent to adopt. As mentioned before, if was left in the model to maintain theoretical integrity, but the relationship is very weak. The same can be said for trialability. The final model suggests that the “try it before you buy it”

As a result, future research practices should include careful review of the survey items for these separate constructs. It perhaps would be more effective to use a mixed methods research model, specifically an exploratory sequential design, that gathers qualitative information first, followed by a quantitative strand. This would allow researchers to explore important factors based on information from fire instructors (Creswell & Clark, 2011), define the constructs more clearly, and then apply the original model from this study to see if the fit works out.

Recommendations

This section will address recommendations for instructor adoption of innovations and for future research. The researcher did not separate the two areas into separate recommendations because they overlap.

1. Consistency in fire service training would be beneficial not only to the trainees, but also the instructors and those who prepare training materials. Standards from the National Fire Protection Association® are often ambiguous and open for interpretation from readers. Clearly defining job performance requirements would lead to clear, definitive learning objectives that would ensure a consistency in the development of curriculum for the fire service.
2. When marketing new innovations to this population, the research from this study indicates that making sure the potential adopters understand the advantages, usefulness, and compatibility of the innovation will increase adoption rates. Marketing materials that include advertising, brochures, social

media campaigns, and live presentations, should emphasize how the LMS technology is compatible with the training job duties already being performed, as well as the aspects of the innovation that can improve on job duties. Demonstrating the usefulness of the tool and the advantages it offers could appeal to this population more than free trial access to the tool or information that promotes how easy it is to use.

3. To mitigate the observability issue within this population, testimonials from peers could increase the observability of the use and effectiveness of a new innovation. Because fire service instructors may not be able to see others using a new technology successfully, using social media, videos, etc., that feature their peers talking about the advantages and usefulness of the technology could also promote adoption.

4. More research should be conducted with this population. This is a unique workforce training environment overflowing with interesting aspects that, when studied, could offer mutual benefit to the discipline and the researchers. For example, grid and group research would provide insight into the culture of the fire service and the best methods for influencing the population. This could be especially helpful when it comes to introducing new ideas and practices. Because the number of people in the population of fire service instructors cannot be clearly identified, this study cannot be definitively generalized. However, the researcher’s work experience in this field says the demographic breakdown of the respondents in this study is fairly accurate, especially when it comes to age and use of computers. This information would

make studies into digital immigrants and digital natives in this population beneficial, especially when it comes to the use of educational technology. Another theory that would provide interesting information about this population is Dunn and Dunn's Learning Styles Model, which could provide insight into the best training methods for not just fire instructors, but firefighters as well. General Decision-Making Styles could also be interesting in this population. The fire service in general is very militaristic and regimented, so how individual decisions are made in this environment could be very interesting. This could tie into the innovation-decision process in DoI as well.

5. Because this population has received little attention in research, the potential for future research is staggering. To name just a few, using DoI theory alone, there are at least five potential areas of research that could be conducted (Rogers, 2003):
    - Dividing adopters into categories based on the timing of adoption
    - Type of innovation-decision process in place in adopter organizations
    - Communication channels that influence adoption
    - Social system influence on adoption
    - Change agent/promotion efforts
6. Conduct mixed methods or qualitative research in order to fill in some of the "whys" that go with the Likert-type scale questions in quantitative research. This would provide the researcher the chance to possibly meet with fire instructors to discuss the details of adoption behaviors. This would also

mitigate the “recall” issue of DoI research. Asking people to remember why they adopted an innovation in the past is a recognized and cited limitation of this study. Future researchers should consider making instructions for instruments very clear in that the reasons for not adopting an innovation are just as important to the research as the reasons to adopt. It should clearly encourage those who do not already use the innovation to participate.

7. Structural equation modeling (SEM), a new statistical methodology the researcher learned specifically for this study, provides a much more in-depth look into the data collected. As this study indicated, simple correlation data provided a brief, quick look into the relationships of the constructs and the intent to adopt. Left at that stage, this researcher would not have been able to make some of the recommendations included here. The addition of SEM, under the tutelage of Dr. Jennifer Cribbs, allowed the researcher to take the research process to the next level and provide more specific information and recommendations about the relationship of DoI and TAM, and the constructs of those with the intent to adopt.
8. The model developed in this study could be used to measure this group’s adoption of other technology. However, there is no guarantee the model with the best fit in this study would fit with a different innovation, even with the same respondents. This is what makes SEM so interesting. The process gives the researcher information about the specific set of data in front of them. While this may not be ideal for the generalization of the quantitative research

in this study, a researcher with more experience in SEM could identify a model that could be more widely implemented.

Summary

Based on the results of this study, fire service instructors were very much like other populations mentioned in literature in that they prefer compatible, useful, and advantageous technology (Burrough, 2015; Chen et al., 2002; Chen, 2014; Dearing, 2009; Doyle et al., 2014; Gouws et al., 2011; Hsu, 2015; Lee et al., 2011; Lee et al., 2003; Marangunic & Granic, 2015; MacVaugh & Schiavone, 2010; Miller & Bull, 2013; Moore & Benbasat 1991; Reggi et al., 2014; Rogers 2003; Rogers et al., 2009; Ryan & Gross, 1943; Singhal, 2012; Surry, 1997; Walker, 2014; Ward, 2013; Wu & Wang, 2005). When it came to testing theory and structural models, this study revealed that, when studying this particular population, it was not necessary to combine DoI theory and TAM. DoI theory alone could be used to measure the adoption behaviors of fire service instructors and used to develop a structural model that could be used to research this population's adoption of other technologies as well.

According to statistics from the U.S. Fire Administration, fires cost the United States $14.3 billion dollars in 2015. More than 3,000 people died and almost 16,000 were injured in the same year. Firefighters who died in 2015 included 9 who died during training activities, 36 who died from activities related to emergency incidents, 17 who died from activities at a fire scene, and 10 who died while responding to emergency incidents. The inclusion of these statistics is not to lay blame at the feet of fire service training. They are included to emphasize the danger of fire service as an occupation and the pressure that danger puts on the brave souls who step-up to train firefighters. The lack of research into fire service instruction as a stand-alone discipline is unfortunate. Perhaps this study will ignite discourse into the need for the research necessary to determine what consistent fire service training looks like and how it should be achieved. Equipping firefighters with the latest and greatest advances in technology should not be limited to the performance of their jobs. It should also extend to the classrooms in which they are trained.

REFERENCES

Agarwal, R. (2000), Individual Acceptance of Information Technologies. *Educational Technology Research and Development, 40*, 90-102.

Agarwal, R., & Prasad, J. (1999). Are individual differences germane to the acceptance of new information technologies? *Decision Sciences*, *30*, 361-391.

Agarwal, R., Sambamurthy, V., & Stair, R. M. (2000). The evolving relationship between general and specific computer efficacy: An empirical assessment. *Information Systems Research*, *11*(4), 418-430.

Aslan, S. & Reigeluth, C.M. (2011). A trip to the past and future of educational computing: Understanding its evolution. *Contemporary Educational Technology, 2*(1), 1-17.

Babbie, E. (1992). *Survey Research Methods* (Second Edition). Belmont, CA: Wadsworth.

Baigent, D., Hill, R., Ling, T., Skinner, D., Rolph, C., & Watson, A. (2003). Sunrise a new dawn in training: Training firefighters today as tomorrow's emergency workers. Retrieved from http://www.fitting-in.com/baigent/sunrise.pdf

Blunch, N.J. (2013). *Introduction to structural equation modeling using IBM SPSS statistics and Amos.* London: SAGE.

Bousbahi, F. & Alrazgan, M.S. (2015). Investigating IT faculty resistance to learning management system adoption using latent variables in an acceptance technology model. *The Scientific World Journal, (2015),* 1-11. doi:10.1155/2015/375651

Bowles, R.P., Grimm, K.J., & McArdle, J.J. (2005). A structural factor analysis of vocabulary knowledge and relations to age. *Journal of Gerontology, 60*(5), 234-241.

Burrough, K. (2015). Factors influencing the adoption of learning management systems by medical faculty. ProQuest Dissertations and Theses.

Butler, W.H. & Goldstein, B.E. (2010). The U.S. fire learning network: Springing the rigidity trap through multiscalar collaborative networks. *Ecology and Society, 15*(3), 21.

Byrne, B.M. (2016). *Structural equation modeling with Amos: basic concepts, applications, and programming.* New York, N.Y: Routledge.

Carter, L. & Belanger, F. (2005). The utilization of e-government services, Citizen trust, innovation, and acceptance factors. *Info Systems J, 15*(1), 5-25. doi:10.1111/j.1365-2575.2005.00183.x

Chang, S. C., & Tung, F. C. (2008). An empirical investigation of students' behavioural intentions to use the online learning course websites. *British Journal of Educational Technology, 39*(1), 71-83.

Childs, M. (2002). Improving the quality of non-emergency leadership: a case study. *Disaster Prevention and Management: An International Journal, 11*(2), 102-108. doi: 10.1108/09653560210426777

Childs, M. (2005). Beyond training: New firefighters and critical reflection. *Disaster Prevention and Management: An International Journal*, *14*(4), 558-566. doi: 10.1108/09653560510618384

Chen, T-L. (2014). Exploring e-learning effectiveness perceptions of local government staff based on the diffusion of innovations model. *Administration & Society, 46*(4), 450-466. doi: 10.1177/0095399713482313

Chen, L., Gillenson, M.L., & Sherrell, D.L. (2002). Enticing online consumers: an extended technology acceptance perspective. *Information & Management, 39*(8), 705-719. doi.:10.1016/S0378-7206(01)00127-6

Clausing, C. & Snyder, L. (Eds.). (2012). *Fire and emergency services instructor.* Stillwater, OK: Fire Protection Publications, Oklahoma State University.

Computer History Museum. (2017). Timeline of computer history. Retrieved from http://www.computerhistory.org/timeline/.

Cokluk, O. and Kocak, D. (2016). Using Horn's parallel analysis method in exploratory factor analysis for determining the number of factors. *Educational Sciences: Theory & Practice, 16*(2), 537-551. doi: 10.12738/estp.2016.2.0328

Coskuncay, F. & Ozkan, S. (2013). A model for instructors' adoption of learning management systems: Empirical validation in higher education context. *TOJET: The Turkish Online Journal of Educational Technology, 12*(2), 13-25.

Costello, A.B. & Osborne, J.W. (2005). Best practices for exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment, Research & Evaluation, 10*(7).

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: SAGE Publications, Inc.

Creswell, J. W. & Creswell, J.D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Thousand Oaks, CA: SAGE Publications, Inc.

Creswell, J. W., & Plano, C. V. L. (2011). *Designing and conducting mixed methods research*. Los Angeles: SAGE Publications.

Cribbs, J.D., Hazari, Z., Sonnert, G., and Sadler, P.M. (2015). Establishing an explanatory model for mathematics identity. *Child Development, 86*(4), 1048-1062. doi: 10.1111/cdev.12363

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. London: SAGE Publications Ltd.

Davis, F.D. (1986). A technology acceptance model for empirically testing new end-user information systems: Theory and results. Doctoral dissertation, Massachusetts Institute of Technology.

Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-340.

Davis, F.D., Bagozzi. R.P., & Warshaw, P.R. (1989). User acceptance of technology: A comparison of two theoretical models. *Management Science, 35*(8), 982-1003.

Dearing, J.W. (2009). Applying diffusion of innovation theory to intervention development. *Research in Social Work Practice, 19*(5), 503-518. doi: 10.1177/1049731509335569

Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education*. New York, N.Y: Macmillan.

Donahue, D.A, Balaban, C.D., Cunnion, S.O. & Sochats, K. (2010). Meeting educational challenges in homeland security and emergency management. *Journal of Homeland Security and Emergency Management*, *7*(1), 1-12.

Doyle, G.J., Garrett, B., & Currie, L.M. (2014). Integrating mobile devices into nursing curricula: Opportunities for implementation using Rogers' diffusion of innovation model. *Nurse education today*, *34*(5), 775-782.

Fahy, R.F., LeBlanc, P.R., & Molis, J.L. (2016) Firefighter fatalities in the United States – 2015. National Fire Protection Association. Retrieved from: http://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/the-fire-service/fatalities-and-injuries/firefighter-fatalities-in-the-united-states

Fasteen, D.J. (2016). Factors that influence the adoption of geographic information systems in a professional work environment: A study of the property assessment profession (Order No. 10248251). Available from ProQuest Dissertations & Theses Global. (1864697004).

FDIC International. (May, 28, 2013). In *Facebook* [Group Page]. Retrieved April 7, 2017, from https://www.facebook.com/notes/fdic/highlights-from-fdic-2013/10151369639812364

FDIC International. (Oct. 13, 2016). In *Facebook* [Group Page]. Retrieved April 7, 2017, from https://www.facebook.com/FDICevent/

Findik, D., & Özkan, S. (2013). A model for instructors' adoption of learning management systems: Empirical validation in Higher Education context. *TOJET: The Turkish Online Journal of Educational Technology*, *12*(2).

Finger, R. (2016). Firefighter training programs: Do the skill or do the drill. *Fire Engineering, (2016)*, 71-79.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research.* MA: Addison-Wesley (out of print). Retrieved from: http://people.umass.edu/aizen/f&a1975.html

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education* (8th ed.). New York: McGraw Hill.

Friere, P. (2000). *Pedagogy of the oppressed.* New York, NY: Bloomsbury Academic.

Gaskin, J. (2016a). Validity master. *Stat Tools Package*. Retrieved from: http://statwiki.kolobkreations.com.

Gaskin, J. (2016b). SEM Series, *Gaskination's Statistics*. Retrieved from: http://youtube.com/Gaskination.

Gaskin, J. (2016c). PatternmatrixbuilderAMOSv24 plugin. *Gaskination's Statistics*. Retrieved from: http://statwiki.kolobkreations.com.

Gaskin, J. (2016d). Mastervalidity24 plugin. *Gaskination's Statistics*. Retrieved from: http://statwiki.kolobkreations.com.

Gaskin, J. (2016e). Factoring methods. *Gaskination's Statistics*. Retrieved from: http://statwiki.kolobkreations.com.

Gautreau, C. (2011). Motivational factors affecting the integration of a learning management system by faculty. *Journal of Educators Online, 8*(1), 1-25.

Gemici, S., Rojewski, J., Lee, I.H. (2012). Treatment of missing data in workforce education research. *Career and Technical Education Research, 1*(2012), 75-99. doi: 10.5328/cter37.1.75

Gouws, T., & van Reede van Oudtshoorn, G.P. (2011). Correlation between brand longevity and the diffusion of innovations theory. *Journal of Public Affairs, 1*(4), 236-242. doi: 10.1002/pa.416

Green, S.B. & Salkind, N.J. (2011). *Using SPSS for Windows and Macintosh: Analyzing and understanding data*. Upper Saddle River, NJ: Pearson Education, Inc., publishing as Prentice Hall.

Gunderson, L. & Holling, C.S. (2002). *Panarchy: understanding transformations in human and natural systems.* Washington, D.C.: Island Press.

Hair, J., Black, W., Babin, B., and Anderson, R. (2010). *Multivariate data analysis* (7th ed.): Prentice-Hall, Inc. Upper Saddle River, NJ, USA.

Hardgrave, B., Davis, F., & Riemenschneider, C. (2003). Investigating Determinants of Software Developers' Intentions to Follow Methodologies. *Journal of Management Information Systems*, *20*(1), 123-151.

Haynes, H.J.G. & Stein, G.P. (2016). U.S. fire department profile -- 2014. Retrieved from http://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/the-fire-service/administration/us-fire-department-profile

Holmgren, R. (2014a). Reformed firefighter training program in Sweden: Conflicting instructor conceptions of professional learning. *Nordic Journal of Vocational Education and Training, 4*(2), 1-19. doi: 10.3384/njvet.2242-458X.14v4i2a5

Holmgren, R. (2014b) Firefighter training in Sweden: from face-to-face learning in training grounds to distance learning – a challenge for exercise instructors? *Technology, Pedagogy and Education, 25*(2), 249-267. doi: 10.1080/1475939X.2014.968197.

Horn, J.L. (1965). A rationale and test for the number of factors in factor analysis. *Psychometrika, 30*(2), 179-185. doi: 10.1007/BF02289447

Hox, J. J., & Bechger, T. M. (2007). An introduction to structural equation modeling. *Family Science Review, 11*, 354-373.

Hoyle, R.H. (Ed). (2012). *Handbook of Structural Equation Modeling.* New York, N.Y.: The Guilford Press.

Hsu, L. (2016). Diffusion of innovation and use of technology in hospitality education: An empirical assessment with multilevel analyses of learning effectiveness. *The Asia-Pacific Education Researcher, 25*(1), 135-145. doi: 10.1007/s40299-015-0244-3

John F. Kennedy Presidential Library and Museum. (n.d.). In *John F. Kennedy Quotations*. Retrieved from https://www.jfklibrary.org/Research/Research-Aids/Ready-Reference/JFK-Quotations.aspx#C

Joseph, L. (2008). The adoption and diffusion of computing and internet technologies in historically black colleges and universities. *The International Journal of Applied Management and Technology, 6*(2), 86-112.

Karahanna, E., Straub, D.W., & Chervany, N. L. (1999). Information technology adoption across time: A cross-sectional comparison of pre-adoption and post-adoption beliefs. *MIS Quarterly*, *23*, 183-213.

Kazmierzak, B.P. (2016). Modern marvels: Firefighter training and technology. *Fire Engineering,169*(5), 22-23.

Kenny, D.A. (2015). *Measuring model fit.* Retrieved from http://davidakenny.net/cm/fit.htm.

Kheel Center, Cornell University. *The 1911 Triangle Factory Fire*, accessed March 29, 2017, http://www.ilr.cornell.edu/index.html

Kline, R. B. (2011). *Principles and Practice of Structural Equation Modeling* (3rd ed.). New York, N.Y.: The Guilford Press

Kobizar, L.N., Rocca, M.E., Dicus, C.A., Hoffman, C., Sugihara, N., Thode, A.E., Varner, J.M., and Morgan, P. (2009). Challenges to educating the next generation of wildland fire professionals in the United States. *Journal of Forestry*, *107*(7), 339-345.

Kodjo, J.Y. (2017). Structural equation modeling analysis of the impact of individualistic-collectivist cultures on consumer decision-making styles and moderating factors of age (Order No. 10272429). Available from ProQuest Dissertations & Theses Global. (1909315247).

Lee, Y.-H., Hsieh, Y.-C., & Hsu, C.-N. (2011). Adding innovation diffusion theory to the technology acceptance model: Supporting employees' intentions to use e-learning systems. *Educational Technology & Society*, *14* (4), 124–137.

Lee, Y., Kozar, K.A., & Larsen, K.R.T. (2003) The technology acceptance model: Past, present, and future. *Communications of the Association for Information Systems, 40*(3), 191-204.

Ledesma, R.D. & Valero-Mora, P. (2007) Determining the number of factors to retain in EFA: An easy-to-use program for carrying out parallel analysis. *Practical Assessment, Research & Evaluation, 12*(2).

Legris, P., Ingham, J., & Collerette, P. (2003) Why do people use information technology? A critical review of the technology acceptance model. *Information and Management*. doi:10.1016/S0378-7206(01)00143-4

Lim, W. M. (2008) Alternative models framing UK independent hoteliers' adoption of technology. *International Journal of Contemporary Hospitality Management, 21*(5), 610-618. doi: 10.1108/09596110910967836

MacVaugh, J. & Schiavone. F. (2010). Limits to the diffusion of innovation: A literature review and integrative model. *European journal of innovation management, 13*(2), 197-221. doi: 10.1108/14601061011060258

Mamadouh, V. (1999) Grid-group cultural theory: an introduction. *GeoJournal, 47*(3), 395-409. doi:10.1023/A:1007024008646

Marangunic, N. & Granic, A. (2015) Technology acceptance model: a literature review from 1986 to 2013. *Universal Access in the Information Society*, *14*(1), 81-95. doi:10.1007/s10209-014-0348-1

Miller, A. & Bull, R.M. (2013). Do you want to play? Factors influencing nurse academics' adoption of simulation in their teaching practices. *Nurse Education Today*, *33*(3), 241-246.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research, 2*(3), 192-222.

Myers, S. (2010). Factors affecting the technology readiness of health professionals. (Order No. 3408097). Available from ProQuest Dissertations & Theses Global. (603172571).

Nachtigall, C., Kroehne, U., Funke, F., and Steyer, R. (2003). (Why) should we use SEM? Pros and cons of structural equation modeling. *Methods of Psychological Research Online, 8*(2), 1-22.

Nja, M.S.O. (2011). Learning amongst Norwegian fire-fighters. *Journal of Workplace Learning, 23*(7), 435-455. doi:10.1108/13665621111162963

O'Connor, B.P. (2000). SPSS and SAS programs for determining the number of components using parallel analysis and Velicer's MAP test. *Behavior Research Methods, Instrumentation, and Computers, 32*, 396-402.

Pinsky, B.M. (2013). Developing a fire service training program. *Fire Engineering, 166*, 93-97, 99.

Phillips, J.M. & Vinten, S.A. (2010). Why clinical nurse educators adopt innovative teaching strategies: A pilot study. *Nursing education perspectives, 31*(4), 226-229.

Reggi, L., Arduini, D., Biagetti, M., & Zanfei, A. (2014). How advanced are Italian regions in terms of public e-services? The construction of a composite indicator to analyze patterns of innovation diffusion in the public sector. *Telecommunications Policy, 38*, 514-529. doi: 10.1016/j.telpol.2013.12.005

Rencher, A.C. and Christensen, W.F. (2012). *Methods of Multivariate Analysis*. Hoboken, N.J.: John Wiley & Sons.

Rogers, E.M. (2003). *Diffusion of innovations*. New York, NY: The Free Press, a Division of Simon and Schuster.

Rogers, E.M., Singhal A., & Quinlan, M.M. (2009) Diffusion of innovations. In D.W. Stacks, & M. Salwen (Eds.), *An integrated approach to communication theory and research* (2nd ed., 418-434). Mahwah, NJ: Lawrence Erlbaum Associates.

Ruiz, J.G., Mintzer, M.J., & Leipzig, R.M. (2006). The impact of e-learning in medical education. *Academic medicine, 81*(3), 207-212.

Rumsey, D.J. (2018). Hot to interpret a correlation coefficient *R*. Retrieved from 1http://www.dummies.com/education/math/statistics/how-to-interpret-a-correlation-coefficient-r/.

Ryan, B. & Gross, N. (1943). The diffusion of hybrid seed corn in two Iowa communities. *Rural Sociology, 8*(1), 15-24.

Saettler, P. (2004). *The evolution of American educational technology*. Greenwich, Connecticut: Information Age Publishing.

Sahin, I. (2006). Detailed review of Rogers' diffusion of innovations theory and educational technology-related studies based on Rogers' theory. *TOJET: The Turkish Online Journal of Educational Technology*, *5*(2), 14-23.

Salkind, N.J. (2011). Statistics for people who (think they) hate statistics. Thousand Oaks, CA: SAGE Publications, Inc.

Schumacker, R.E. & Lomax, R.G. (2010). A beginner's guide to structural equation modeling. New York, NY: Taylor and Francis Group.

Shay, C. (2010). Training rural departments. *Fire Engineering,163*(10),14-18.

Singh, G. & Hardaker, G. (2014). Barriers and enablers to adoption and diffusion of e-learning. *Education+ Training, 56*(2/3), 105-121.

Singhal, A. (2012). Everett M. Rogers, an intercultural life: from Iowa farm boy to global intellectual. *International Journal of Intercultural Relations, 36,* 848-856. doi:10.1016/j.ijintrel.2012.08.015

Smith, V., Abrams, A., & Brakhage, C. (Eds.). (2015). *Fire and emergency service orientation and terminology.* Stillwater, OK: Fire Protection Publications, Oklahoma State University.

Spector, J.M. (2012). *Foundations of Educational Technology.* New York, N.Y.: Taylor & Francis.

Surry, D.W. (1997, February). *Diffusion theory and instructional technology*. Paper presented at the Annual Conference of the Association for Educational Communications and Technology (AECT), Albuquerque, NM.

Taylor, S., & Todd, P.A. (1995). Understanding information technology usage: a test of competing models. *Information Systems Research, 6*(1), 144-176.

Teddlie, C. & Yu, F. (2007). Mixed methods sampling: A typology with examples. *Journal of Mixed Methods Research, 1*(1), 77-100. doi: 10.1177/2345678906292430

U.S. Fire Administration. (2018). In *U.S. Fire Statistics*. Retrieved from https://www.usfa.fema.gov/data/statistics/

Venkatesh, V., & Davis, F.D. (2000) A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science, 46*(2), 186-204.

Von Dehle, D. (2006, August). Uncovering the history of the triangle shirtwaist fire. *Smithsonian Magazine.* Retrieved from http://www.smithsonianmag.com/history/uncovering-the-history-of-the-triangle-shirtwaist-fire-124701842/

Walker, D.S. (2014). Attributes and barriers that influence the adoption and diffusion of a learning management system. (Order No. 3667660). Available from ProQuest Dissertations & Theses Global. (1650238935).

Ward, R. (2013). The application of technology acceptance and diffusion of innovation models in healthcare informatics. *Health Policy and Technology*, *2*(4), 222-228.

Wener, R., Panindre, P., Kumar, S., Feygina, I., Smith, E., Dalton, J., & Seal, U. (2015) Assessment of web-based interactive game system methodology for dissemination and diffusion to improve firefighter safety and wellness. *Fire Safety Journal, 72*, 59-67. Retrieved from doi: 10.1016/j.firesaf.2015.02.005

Wong, L., Tatnall, A, & Burgess, S. (2013) A framework for investigating blended learning effectiveness. *Education + Training, 56*(2/3), 233-251. doi: 10.1108/ET-04-2013-0049

Wood, N.D., Akloubou Gnonhosou, D.C., & Bowling, J. (2015). Combining parallel and exploratory factor analysis in identifying relationship scales in secondary data. *Marriage Fam Rev, 51*(5), 385-395. doi: 10.1080/01494929.2015.1059785

Wu, J. H., & Wang, S. C. (2005). What drives mobile commerce? An empirical evaluation of the revised technology acceptance model. *Information Management, 42***,** 719–729. doi:10.1016/j.im.2004.07.001

Yong, A.G. & Pearce, S. (2013). A beginner's guide to factor analysis: Focusing on exploratory factor analysis. *Tutorials in Quantitative Methods for Psychology*, *9*(2), 79-94. doi: 10.20982/tqmp.09.2.p079

APPENDIXES

APPENDIX A

PARTICIPANT INVITATION

Email Invitation:

Good afternoon!

My name is Tara Roberson-Moore and I am a Ph.D. student in Workforce and Adult Education at Oklahoma State University.

I write to you today to ask for your assistance with my dissertation research. By taking a few minutes to answer the short survey at the link below, you will be providing valuable information about the adoption and use of Learning Management System (LMS) technology as a fire service instructor.

Participation is completely voluntary and all answers are anonymous.

Thank you in advance for your assistance with this study.

Tara Roberson-Moore

Survey Information

Title: Adoption of Learning Management System Technology by Fire Service Instructors

Investigators(s): Tara Roberson-Moore

Purpose: The purpose of this study is to research factors that influence fire instructor adoption of LMS technology.

What to Expect: You will complete a survey.

Risks and Benefits: There are no risks involved in participating in this study. This study may include risks that are unknown at this time. There are no personal benefits for taking part in this research.

Compensation: None.

Audio Recording and Notes: None.

Contacts: You may contact the researcher at the following address and phone number, should you desire to discuss your participation in the study and/or request information about the results of the study: Tara Roberson-Moore, tara.roberson-moore@okstate.edu, (405) 269-1055. For information about your rights as a subject, please contact the OSU IRB at 405-744-3377 or irb@okstate.edu.

Participant Rights: I understand that my participation is voluntary, that there is no penalty for refusal to participate, and that I am free to withdraw my consent and participation in this project at any time, without penalty.

Consent Documentation: I have been fully informed about the procedures listed here. I am aware of what I will be asked to do and of the benefits of my participation. By completing the survey, I am affirming that I am 18 years of age or older, that I understand the information in this form, and that I am participating freely and voluntarily.

LINK TO SURVEY

APPENDIX B

MODIFIED INNOVATION ADOPTION/TECHNOLOGY MODEL QUESTIONNAIRE

Learning Management System (LMS): Any technology that provides a single, online location for all curriculum and learning resources.

Instructors, fire departments, and educational institutions who deliver training using fire service manuals typically have access to instructional materials in an easy-to-access web-based environment.

This technology typically provides instructors with a way to set up and manage individual courses; conduct online assessments and evaluations; provide all learning materials for a particular course including, but not limited to, electronic texts, PowerPoint presentations, and additional curriculum components; engage students outside of the classroom with discussion boards; make individual remedial assignments to assist learners to name a few.

Examples include: Blackboard, ResourceOne (R1), Moodle; Litmos, Chamilo, SABA, Navigate 2, ShareKnowledge for SharePoint, or any other platform that offers any of the above-referenced capabilities.

As you answer the following questions, please consider what you know about LMS technology, *whether you currently use it or not.*

I think that using LMS technology fits well/will fit well with the way I like to work.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Using LMS technology fits/will fit into my work style.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Using LMS technology is appropriate for my teaching style.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Using LMS technology is compatible with most of my teaching.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

As you answer the following questions, please consider what you know about LMS technology, *whether you currently use it or not*.

Learning LMS technology was/will be easy for me.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
I think LMS technology is clear and understandable.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
I think LMS technology is/will be easy to use.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

As you answer the following questions, please consider what you know about LMS technology, *whether you currently use it or not*.

Using LMS technology enables/will enable me to accomplish tasks more quickly.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Using LMS technology improves/will improve the quality of the work I do.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Using LMS technology makes it/will make it easier to do my job.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Using LMS technology enhances/will enhance my effectiveness on the job.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Using LMS technology increases/will increase my productivity.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

If you currently use LMS technology: please think back to your decision-making processes when answering these questions.

If you do not currently use LMS technology, think about what would be important to you before making a decision about whether or not to try it.

Before deciding on whether or not to use LMS technology, I saw a lot of others in my field using LMS technology.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Before deciding on whether or not to use LMS technology, I saw demonstrations of LMS technology.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Before deciding on whether or not to use LMS technology, I did not see many people using LMS technology.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

If you currently use LMS technology: please think back to your decision-making processes when answering these questions.

If you do not currently use LMS technology, think about what would be important to you before making a decision about whether or not to try it.

Before deciding on whether or not to use LMS technology, I was permitted to use it long enough to see what it could do.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Before deciding on whether or not to use LMS technology, I was able to try its various options.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

Before deciding on whether or not to use LMS technology, I already had a task in mind to test it.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

As you answer the following questions, please consider what you know about LMS technology, *whether you currently use it or not*.

Using LMS technology enhances/will enhance my effectiveness as a teacher.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Using LMS technology will improve my teaching performance.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Using LMS technology will make it easier to teach course content.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
I find LMS technology to be easy to use.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
It is easy to perform work using LMS technology.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
I clearly understand how to use LMS technology.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
I intend to use or continue using LMS technology in the next 6 months.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
I intend to use or continue using LMS technology as an autonomous learning tool.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
I intend to use or continue using LMS technology to assist my teaching.	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

Demographics

Use this scale to rate your experience level as an instructor:

Interacting and collaborating with students.	**No experience**	**Some experience**	**Fairly confident in my experience level**	**Very confident in my experience level**	**So confident, I could train other instructors**
Managing classroom organization	**No experience**	**Some experience**	**Fairly confident in my experience level**	**Very confident in my experience level**	**So confident, I could train other instructors**
Managing classroom time	**No experience**	**Some experience**	**Fairly confident in my experience level**	**Very confident in my experience level**	**So confident, I could train other instructors**
Organizing curricular goals, lesson plans, and instructional delivery	**No experience**	**Some experience**	**Fairly confident in my experience level**	**Very confident in my experience level**	**So confident, I could train other instructors**
Using student assessment and feedback to maximize instructional effectiveness	**No experience**	**Some experience**	**Fairly confident in my experience level**	**Very confident in my experience level**	**So confident, I could train other instructors**
Integrating technology in the classroom	**No experience**	**Some experience**	**Fairly confident in my experience level**	**Very confident in my experience level**	**So confident, I could train other instructors**
Developing a professional identity as an instructor	**No experience**	**Some experience**	**Fairly confident in my experience level**	**Very confident in my experience level**	**So confident, I could train other instructors**
Enhancing professional relationships with colleagues	**No experience**	**Some experience**	**Fairly confident in my experience level**	**Very confident in my experience level**	**So confident, I could train other instructors**
Presentation skills and teaching techniques	**No experience**	**Some experience**	**Fairly confident in my experience level**	**Very confident in my experience level**	**So confident, I could train other instructors**

Gender:

Female

Male

Age:

Race/Ethnicity:

White

Hispanic or Latino

Black or African American

Native American or American Indian

Asian/Pacific Islander

Other

Highest Level of Education:

High School

College/University degree

Master's Degree

Doctoral Degree

Other

How long have you been using computers in a work environment?

Less than 1 year

1-3 years

3-6 years

6-9 years

More than 9 years

Type of Fire Service Training Organization:

Volunteer Department/District

Fire Service Training Organization

State Fire Service Training Agency

Local Department

Technical School

Higher Education

Do you currently use LMS technology?

Yes

No

Don’t know

Which LMS technology have you used? (Provide a list.)

VITA

TARA ROBERSON-MOORE

Candidate for the Degree of

Doctor of Philosophy

Thesis: ADOPTION OF LEARNING MANAGEMENT SYSTEM TECHNOLOGY BY FIRE SERVICE INSTURCTORS

Major Field: Education

Biographical:

Education: Completed the requirements for the Doctor of Philosophy in Education at Oklahoma State University, Stillwater, Oklahoma in May, 2018. Completed the requirements for the Master of Science in Criminal Justice from Northeastern State University, Broken Arrow, Oklahoma in May, 2006. Completed the requirements for the Bachelor of Science in Journalism from Oklahoma State University, Stillwater, Oklahoma in May, 1992.

Experience: Education consultant and contractor, LEAD Training, LLC; Lead Instructional Developer, Fire Service Publications, Oklahoma State University; Information Services; Coordinator/ISD-EBS Training, State of Oklahoma, Office of Management and Enterprise Services. Federal Grant Programs Manager, State of Oklahoma, District Attorneys Council.

Professional Memberships: American Education Research Association (AERA) and Association for Career and Technical Education Research (ACTER).