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Organizational Readiness for the disruptive technology of autonomous commercial vehicles (ACV): What is the readiness of the trucking carriers?

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Organizational Readiness for the disruptive technology of autonomous commercial vehicles (ACV): What is the readiness of the trucking carriers?

by

M. Carey Dukes Jr.

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree

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ACCEPTANCE

This dissertation was prepared under the direction of the *MELVIN CAREY DUKES JR.* Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Business Administration in the J. Mack Robinson College of Business of Georgia State University.

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ABSTRACT

Organizational Readiness for the disruptive technology of autonomous commercial vehicles (ACV): What is the readiness of the trucking carriers?

by

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The trucking industry contributes $972 billion to U.S. gross domestic product and is responsible for moving in excess of 10 billion tons per year. The industry has faced significant challenges with driver shortages as well as high turnover. Additionally, over thirty-five thousand people lost their lives on U.S. highways in 2015, and 94% of these deaths were attributed to human error. Technologists are developing autonomous vehicle (AV) technology to address some of these challenges. AV technology has advanced significantly over the past decade and is now at a point where it is not a matter of if it is possible but when it will happen. This research will focus specifically on the carriers' ability to implement autonomous commercial (i.e. trucks) vehicles (ACV), that could have the possibility of replacing truck drivers. Our investigation concerns the organizational readiness of trucking carriers, positing the following research question: What is the organizational readiness for the disruption caused by autonomous commercial vehicles (trucks)?

INDEX WORDS: autonomous vehicles, readiness for change, change management, transportation

I INTRODUCTION

The trucking industry is one of the largest employers in the United States. The industry employs over 1.7 million drivers, according to the Bureau of Labor and Statistics 2017. The trucking industry is composed of commercial trucking companies licensed to operate trucks hauling up to 80,000 pounds combined vehicle and equipment weight. While autonomous vehicle adoption will affect all areas of transportation, such as taxi drivers, busses, airlines and rail this study will focus specifically on the commercial trucking companies. Technology predictors believe we are on the cusp of a technological revolution that will displace millions of workers, especially in transportation related fields (Kopf 2017, Beede et al., 2017, DOT 2016).

In the summer of 2016, the annual Automated Vehicle Symposium held each year since 2014 attracted less than 400 attendees. In the summer of 2017, the same conference saw almost 1500 in attendance. In late 2016, Honda announced it will implement Waymo technology (an independent company of Alphabet Inc.) specifically focused on developing autonomous vehicle technology by 2020.

Likewise, Jeff Williams, Chief Operating Officer of Apple Inc. indicated in 2017 the ultimate sharing device was the automobile (Williams 2017) indicating a growing area of interest to integrate automobile technology with other mobile applications. In February 2017, former Ford CEO Mark Fields announced Ford will be making cars without steering wheels by 2021. When asked in October of 2017 how close Waymo is to implementing autonomous vehicles Waymo CEO John Krafcik confirmed while they did not want to set a definitive date they were in fact very close to making the technology available and implementing autonomous vehicles. He also confirmed they are working hard to get the autonomous car on the public roadways (Bloomberg 2017). In October of 2017, Embark, an autonomous vehicle startup began using self driving trucks to operate between El Paso, TX and Palm Springs, CA (Davies 2017). On February 6th 2018, Embark also announced they had completed a 2,400-mile cross-country trip from Los Angeles, CA to Jacksonville, FL with autonomous technology used to assist a driver during the journey (Etherington 2018). While this technology is not intended to completely replace the driver in the near term, it intends to reduce the number of team drivers required to make long haul movements. Variations on this technology approach are being explored by other companies as well and may provide an interim step towards eliminating the driver altogether.

Increased attention on AV will continue to affect the development of the technology. The focus of this research will be the trucking carriers. There are more than 500,000 carriers currently operating within the United States (DOT 2016), and all of these companies will be affected by the implementation of autonomous vehicles (CB Insights 2018).

We use the lens of Organizational Readiness to Implement Change (Weiner 2009, Shea et al., 2014) to study the topic. Organizational Readiness to Implement Change is considered a shared psychological condition to facilitate organizational members to feel committed and to value implementing organizational change (Weiner 2009). The theory posits that several factors including the value for the change, the availability of resources, the belief the firm can execute the change, and commitment of the firm to make the change all lead to change related effort. This change related effort provides a direct link to implementation readiness. Additionally, we also asked questions concerning the contextual environment within the firms, and what the perception of these environments were, and how this change would be viewed.

With the effort underway to develop autonomous vehicles. this study seeks to investigate the readiness of the trucking carriers to implement these changes. It will be beneficial to both practitioners and researches to further understand the current state of readiness of the carriers as technological development continues.

Our study divides the trucking eco-system into two areas: Direct and Indirect participants as illustrated in Figure 1. Carriers, brokers, shippers, receivers, and third-party logistics providers are considered Direct Participants because they have a direct relationship with the truck drivers. Technology firms, truck manufacturers, insurance providers, policy makers, and regulatory agencies are labeled Indirect Participants because they do not interact with the truck drivers directly, however, when combined with the direct participant groups, they make up the trucking eco-system. The scope of this study will be restricted to the carriers. Carriers will be the first and most directly affected group by the implementation of fully or assisted autonomous commercial vehicles (ACV). ACV implementation will require an overhaul of existing processes and procedures because the human driver will no longer be a part of business operations.

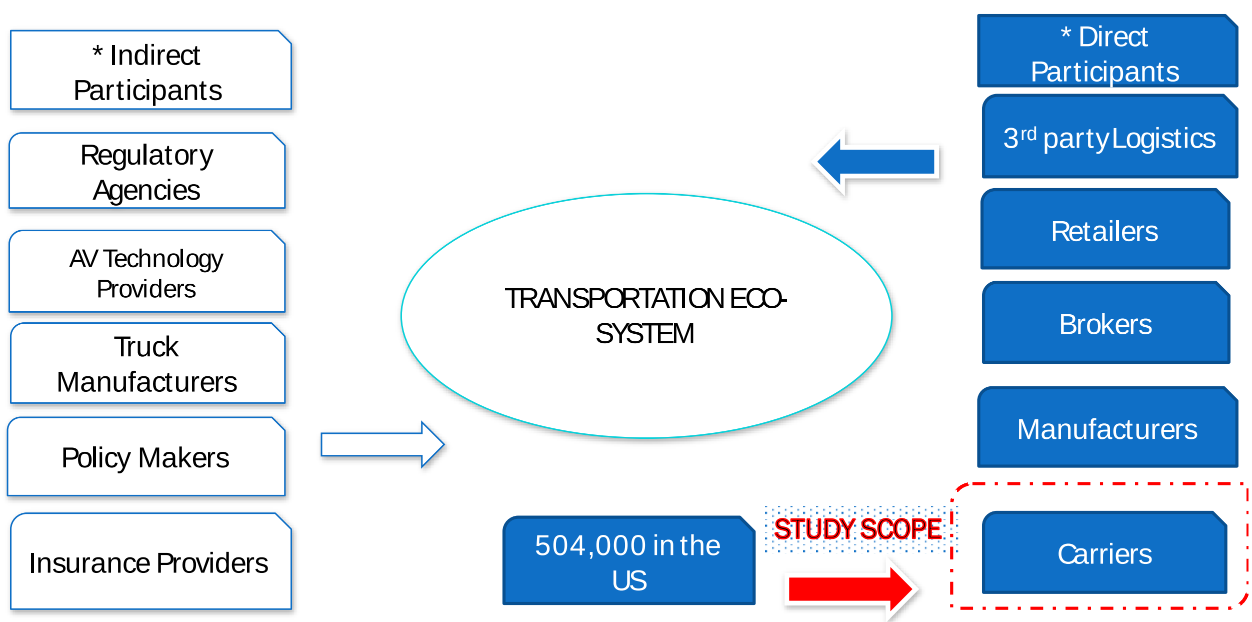

Figure 1:: Trucking Eco-System

II LITERATURE REVIEW

II.1 Trucking Industry

The trucking industry contributed $972 billion in 2015 with $482 billion of that being from for hire trucking companies. $972 billion represents 2.6 percent of the U.S. GDP (BTS 2017). The trucking industry is responsible for moving more than 10 billion tons per year over existing freight lanes (ATA 2017). These lanes are a network of interstate, state, and local highways that facilitate movement of products. The systems of roads within the US function similarly to the functions in the human body of the arteries and veins. These roads operate as a product delivery mechanism to facilitate the transfer of goods across the country.

The Bureau of Labor and Statistics reports there are 140 million people working in the US (BLS 2017). Of these, the BLS assigns each person into one of 1,088 job classifications. Commercial Truck Drivers rank as the 68th most popular job classification based on the number of people performing the job, and the BLS reports there were 1,704,520 people working as commercial truck drivers in 2016 (BLS 2017). Additionally, 350,000 owner-operators were working for carriers in 2016 according to the Owner-Operator Independent Driver Association which are not included in the 1.7 million drivers reported by the BLS.

Although many people are involved in the industry, the industry is highly fractured: Ninety-nine percent of all commercial carriers are considered small businesses (Costello 2013). The trucking industry is a network of carriers as demonstrated by the top 250 trucking companies representing only 492,000 of the more than two million total trucks on the highways (CCJ 2015). Based on a report by the Department of Transportation there are over 500,000 carriers operating in the U.S. (DOT 2016). On average, there are roughly four drivers for each carrier operating in the U.S. These drivers and carriers constitute a broad range of businesses, who operate along the spectrum of technological innovation ranging from multi-billion dollar industries to individual operators working out of rented space using fax machines and personal email accounts to conduct business. Over the last century, the industry has seen many challenges and changes.

When the automobile was first introduced people realized they could use the invention to transport goods to businesses and individuals. Later, with the advent of the interstate system, the industry saw an increase in the size and capability of the trucks in the distribution system. In 1980, the federal government deregulated the trucking industry. This allowed millions of participants to enter a previously protected market. One of the most significant effects of deregulation was to allow smaller operators to begin to participate. Later in the 1980's and 1990s, companies began to focus on reducing their inventory carrying costs and increasing the efficiencies of their supply chains. This added a new level of responsibility to the carriers. With lower levels of inventories in warehouses, trucking performance became more critical (Costello 2013). These changes dramatically affected the industry by requiring smaller deliveries more frequently, but through it all one thing remained constant: the driver. The driver of the truck was always essential, and the growth of the industry allowed millions to earn a living driving a commercial vehicle. Autonomous vehicles will, for the first time, eliminate the need for the driver. This will cause foundational changes in the transactional processes of these business that are built on interfacing with the driver for all participants in the eco-system.

II.2 Autonomous Vehicles

The ability for a vehicle to operate without a driver has long been a goal. Leonardo Da Vinci invented a self propelled cart using springs and pulleys in 1478 (Da Vinci 1478). Nicholas Tesla made a proposal to the U.S Navy to provide a design for ~~a~~ radio-controlled ship in the early 1900s (Tesla 1913). In the past, these concepts were considered science fiction. This is no longer the case. A simple search of scholarly journals containing the words "autonomous vehicle" indicates a dramatic increase in the number of sources studying this topic, especially in the last 12-15 years. This increase is illustrated in Figure 2. Examples of the over 100 scholarly peer reviewed journals reporting results for this search included:

Behavioral and Brain Sciences (876), Applied Mechanics and Materials (690), Plos One (680), Mathematical Problems in Engineering (423), and Robotica (354)

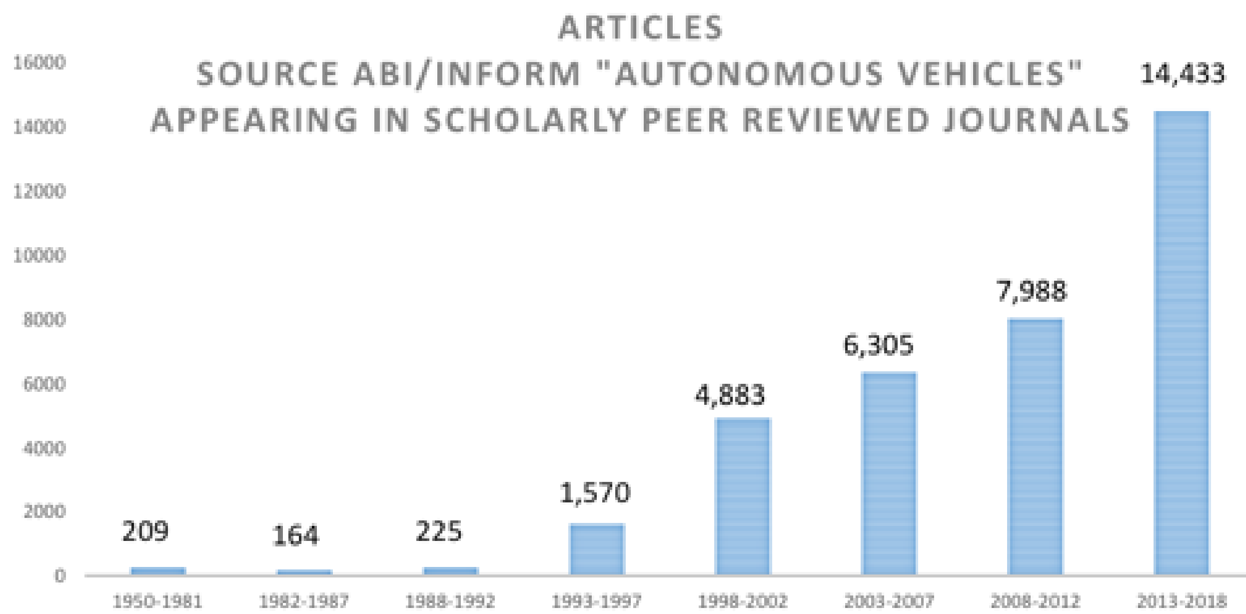

Figure 2:Journal Publications

Moore's law states that computer processing capabilities double every 18-24 months (Moore 1965), and has now reached a point where the technological capabilities of processors and sensors can handle the demands of a vehicle operating without a driver. However, having the technological capabilities is not the same as needing to implement them. The federal government has embraced this technology as a way to help improve safety on the highways. The combination of technological advances and public policy decisions has contributed to the explosion of interest and involvement in the development of autonomous vehicles.

A study commissioned by the National Highway and Safety Administration through Indiana University determined 93% of all traffic accidents involved human error (Treat 1979).

While deaths per billion miles traveled have continued to decline due to the continued focus on safety and education, in 2013, The National Safety Council reported there were 5,687,000 crashes on US roadways (NSC 2013). 1.2 million of these accidents were caused by distracted drivers. (NSC 2013). Distracted driving has been on the rise in the last few years due to increased interaction with electronic devices. The United States Department of Transportation reported 3,477 people died in accidents involving distracted drivers in 2014 (US DOT 2017). Likewise, 424,000 people were injured in accidents where distracted driving was involved (HG 2013). In 2015, there was a sharp increase in deaths on the US roadways during that year from 32,675 in 2014 to 35,092 in 2015 (NHSTA 2017). Based on prior research, over 90% of these deaths were attributable to human error (Treat 1979, DOT 2016).

Autonomous vehicles advocates are hopeful this new technology will reduce some of these deaths (DOT 2016). In September of 2016, the United States Department of Transportation along with the National Highway Safety Administration issued a guidance concerning autonomous vehicles. Federal Automated Vehicle Policy is intended to provide guidance to federal, state and local agencies as the technology develops. (DOT 2016). The goal of the guidance is to provide a framework to assist in the adoption of AV technology throughout the US. This guidance along with other government initiatives demonstrates the belief in and the commitment to this technology. As stated in the guidance, the rise in the technology is inevitable; there will be significant safety implications for providing guidance early in the process, and, finally, as this technology grows, the unknowns of today will be known tomorrow (DOT 2016).

As referenced in Table 1, The National Highway Safety Administration (NHSTA) has adopted a six-stage level of automation.

Table 1: Levels of Automation

Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
No Automation	Driver Assistance	Partial Automation	Conditional Automation	High Automation	Full Automation
Zero autonomy; the driver performs all driving tasks.	Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.	Vehicle has combined automated functions, like acceleration and steering, but the driver is engaged with the driving task and monitor the environment at all times.	Driver is a necessity, but is required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.	Vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.	The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.

Source: DOT HS 812 442 September 2017

Table 2: Future of Driverless Vehicles

Company	Impementation	Comment	Source
Nutonomy	2018	Taxi Service in Singapore	Digital Trends 2016
Delphi/MobileEye	2019	Level 4 sytem on the market by 2019	The Verge 2016
GM	2020	Expects self driving cars on the market by 2020	Wall Street Journal 2016
Nissan	2020	Driverless cars coming to showrooms	Nissan Motors 2013
Ford	2021	No steering wheels or pedals in targeted fleets	Reuters 2016
BMW	2021	CEO Harold Krueger says they will launch the BMW inext	Elektrek 2016
Nvidia	2022	It will take no more than four years to have fully autonomous cars on the road	Reuters 2017

The future of driverless vehicles is still unknown but several industry leaders have chimed in on their opinion of when the technology will be available to the public. Some of these predictions have been included in Table 2. While significant portions of prior research concerning driverless technology has focused on the technical and legislative aspects of the technology (Fleetwood 2017, Gerdes and Thornton 2016, Miller 2016, Anderson et al., 2017, Brodsky 2017, Lin 2016, Uber 2016), there have been recent efforts to begin to examine the potential for public acceptance (Menon, N 2017 and Merat et al., 2017 and Schoonmaker 2016). Likewise, the ethical choices these vehicles will need to be programmed to make (Fleetwood 2017 and Borenstein et al., 2017, Etzioni & Etzioni 2017), and the impact autonomous vehicles will have on trust are beginning to be examined. Many companies are racing to be significant providers of this technology. Figure 3 illustrates a representative sample of the companies currently developing driverless technology applications. Ford, General Motors and Renault-Nissan are considered by many industry insiders as being the most likely providers to be the first to the market with a fully autonomous vehicle by as early as 2020 (Driverless Future 2018). While the majority of these providers are working on driverless cars, the technology is also being applied to the trucks as well. For examples, Embark is working closely with one of the largest trucking manufacturers, Freightliner and Peterbilt, in their driverless technology research already being used on US highways (Self Driving trucks 2018).

Figure 3: Companies developing AV technology

Legislation is still in development at the state level to allow autonomous vehicles on the roads as illustrated in Figure 4. As of January, 2018 five states CA, NV, TN, MI and FL have passed legislation allowing autonomous vehicles to operate within their states.

Partially in response to the issues related to legislation, in 2016 the National Safety Highway Administration (NHSTA) in conjunction with the Department of Transportation (DOT) began issuing periodic guidance to industry participants. In it’s latest revision titled Automated

Driving System 2.0, released in September 2017, the group further defined the role of industry participants. Policy makers and technology providers are working together towards a world in which autonomous vehicles become a reality.

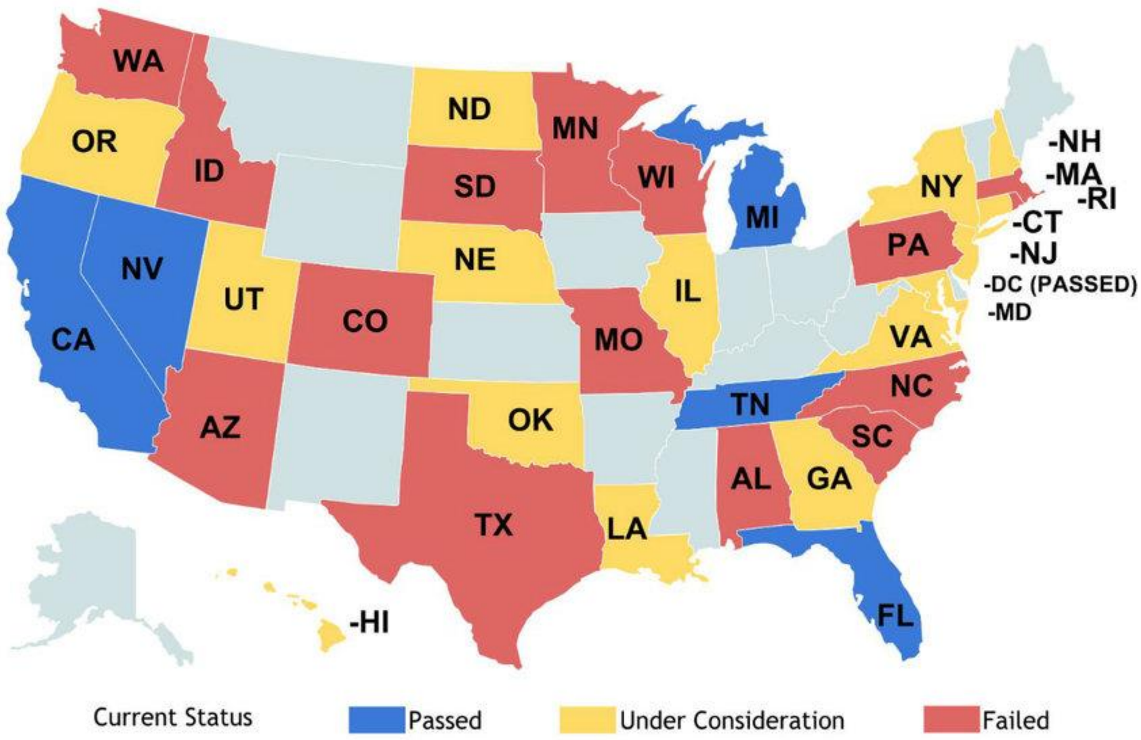

Figure 4: Status of AV legislation January 2018
Source:

http://cyberlaw.stanford.edu/wiki/index.php/Automated_Driving:_Legislative_and_Regulatory_Action accessed on January 17th 2018

II.3 Change Management

'It is not necessary to change. Survival is not mandatory.'

W. Edwards Deming (retrieved 02.17.18)

Changing individuals, teams and organizations from a current state to a desired future state by modifying and transitioning these groups from where they are to where they need to be is change management (Tamilarasu, V. (2012). Change management has been studied for years to understand what is needed to to implement change effectively. In his highly regarded book on change management, Kotter (1996) presented a model of eight critical steps to change management. These steps included:

Create Urgency

Form a powerful coalition

Create a vision for the change

Communicate the vision

Remove obstacles

Create short term wins

Build on the change

Anchor the change in the corporate culture

While these steps provide a framework to understand effective change management at the leader level, this framework does not address the question of organizational readiness nor focus on the perspective of the change agents within in the firm who may be tasked with making the change effective within the organization.

II.4 Literature Review for Readiness

Table 3: Prior Organizational Readiness Studies

The research model was developed based on the contributions illustrated in Table 3.

Construct	Definition	Reference
Change Valence	Organizational value for the change	Fishbein 1975, Weiner 2009
Informational Assessment	Organizational task demands, resources perception and situational factors	Weiner 2009, Shea et. al 2014, Hannon et. al 2017
Change Efficacy	Comprehensive summary or judgment of perceived capability to perform a task	Gist and Mitchell 1992
Change Commitment	Collective shared resolve to pursue a course of action	Shea et. al 2014
Dependent Variable Change Related Effort	Initiation, persistence and cooperative behavior	Bandura 1997, Herscovitch and Meyer 2002, Weiner 2009

We draw from prior researchers who have studied change management and more specifically organizational readiness to implement change. (ORIC) Informed by the ORIC framework, we present a model of organizational readiness to implement changes as depicted in Figure 5: ACV Organizational Readiness for Implementing Change Model. The model identifies five factors across the three ORIC contexts that affect change related effort. The model is holistic and generalizes psychological constructs that are essential to organizational readiness.

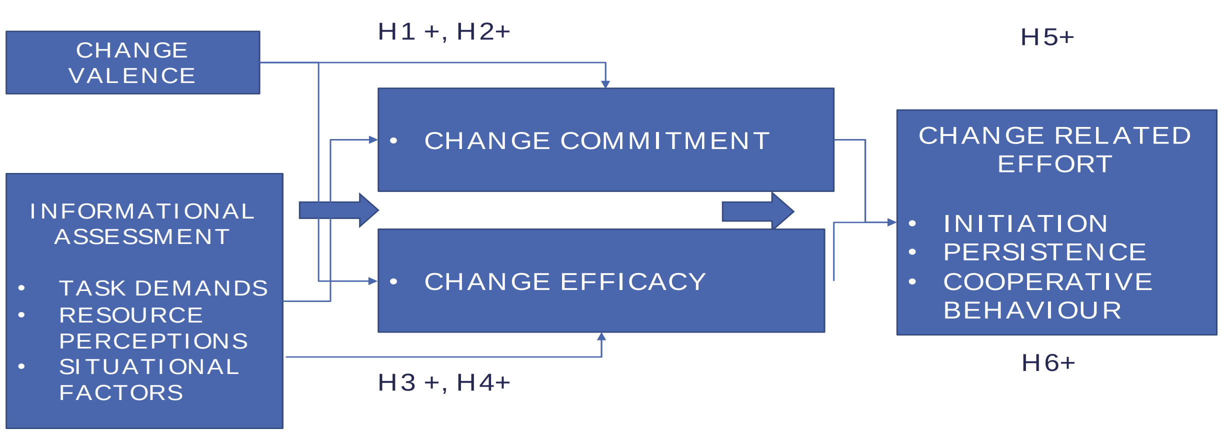

Figure 5: ACV Organizational Readiness for Implementing Change Model (adapted from Shea et. al 2014)

III THEORETICAL FRAMEWORK

III.1 Change Readiness

Armenakis et al. 1993 posited readiness as a mental predecessor of actions or beliefs to support or resist organizational change. While significant resources have been developed to study change management half of these initiatives fail because of lack of organizational readiness (Kotter 1996). The concept of readiness in everyday discourse connotes a proactive or responsive state of preparedness toward a future action (Weiner et al., 2017). In 1993, two researchers from Auburn University, A.A. Armenakis and S.G. Harris, attempted to understand the component issues of organization readiness. The focus was on the recipient of change initiatives and their motivations, or lack thereof, to implement the change. The results of their research produced five key change beliefs:

1 – Discrepancy - the belief that change is needed

2 – Appropriateness - the belief that a specific action to address the change needed is the correct strategy

3 – Efficacy - the belief that both the recipient and the organizational can implement the change

4 – Principal Support - the belief that formal leaders are committed to the change

5 – Valence - the belief that the recipient values the change and there is something in it for them (Armenakis et.al, 1993).

III.2 Organizational Readiness to Implement Change

Change attitudes play a significant role in change readiness. Specifically, the value for the change can be a significant component of change readiness. Does the firm believe the change will add value? As described by Fishbein (1975) the value the firm places on the change is an important attitude that must be understood to evaluate the readiness of the firm for change.

It does not necessarily require the members of the firm to value the change for the same reason but it does require that the change is valued.

Belief in an organization's ability to implement the change is organizational change efficacy. Gist and Mitchell 1992 contend this is a key element of change. It is a malleable and complex construct in that its determinants are influenced by perceptions of the organizations to implement a theoretical change.

Change related effort occurring is a key determinant of progression towards implementation readiness (Bandura 1997, Herscovitch and Meyer 2002, Bandura 1997,). Evidence of effort occurring signifies to the members of the firm the change is imminent and is important. Examples of change related effort include, dedicating resources to the change, dedicating coordinators as a central point of contact and organizing committees to study the efforts required to effectively implement the change.

Drawing from the work by Fishbein (1975), Armenakis and Harris (1992), Gist and Mitchell (1992), and Herscovich and Meyer (2002), Weiner (2009) introduced a model of organizational readiness to implement change. Weiner described organizational readiness for change as a multi-level, multi-faceted construct. He also considers it a group psychological state of being in which organizational members feel compelled and committed to implementing the desired organizational change. Implementation readiness requires collective behavior to be consistent with driving the desired change (Weiner 2009). It also allows for combining the structural and psychological views held by an organization concerning their readiness to implement change. The theory proposes that the organization is affected by various antecedents, including change valence, informational assessment, organizational readiness for change (i.e. change commitment and change efficacy), leading to change-related effort (Weiner 2009).

The main concepts of Weiner's model are as follows:

Change Valence – Does the organization value the proposed change? It is not important that the members value the change for the same reason: only that it is valued. The most significant question being asked is, regardless of why each individual perceives their own reasons, do the members collectively value the change enough to commit to implementation? (Weiner 2009)

Informational Assessment - Several past studies have posited informational assessment as a key determinant of change efficacy and change commitment (Weiner 2009, Shea et al., 2014, Hannon et al., 2017). This assessment includes the organizational task demands, resource perceptions, and situational factors. Do the members of the organization believe they have the resources and freedom of time and attention to make the change?

Change Efficacy - Perceived organizational capability, defined by Gist and Mitchell (1992) as change efficacy, can be a determinant of an organizations change related effort (Weiner 2009). Do the members of the organizational believe they are capable of making the change?

Change Commitment – To the extent the organization has a desire to pursue a course of action could be considered the firms' commitment to change (Shea et al., 2014) and this can be a key determinant at the firm. Do the members believe there is a commitment within the organization to make the change?

Change Related Effort – An organization 's structural changes made specifically in preparation for the change in question. These include forming committees and assigning tasks and individuals within the organization to facilitate the eventual implementation of the change.

Drawing on prior research by Weiner (2009), Shea et al., (2014) sought not only to test the theory, but further refine the constructs that determine an organization's readiness for change. This study tested the theory using a survey developed from interviews with organizational participants and tested the survey questions using four independent respondent groups in multiple settings. From this study, Shea et al. (2014) developed ORIC, which he defined as Organizational Readiness for Implementing Change. Hannon et al., (2015) developed a pilot questionnaire and tested its validity based on the path analysis of Organizational Readiness for Change. These studies, as well as a study in development by Weiner et al., (2017), are referenced in Table 2. Both Shea et al., (2014) and Hannon et al., (2017) validated the theory, and their developed measures. Each of these studies focused on the healthcare sector. We will apply this theory Organizational Readiness to Implement Change to the trucking industry.

III.3 Context

Prior research indicates there may be contextual environments at the firm that may influence perceptions of organizations relative to change (Armenakis 1993, Adelman and Taylor 1997, Johns 2001, and Holt 2006). These contextual influences may include organizational culture, policies and procedures, past experiences, organizational resources and organizational structure (Weiner et al., 2009). These contextual predispositions may influence different variables in different ways. For example, past experiences with change could influence change valence positively or negatively in part based on the perceptions of previous efforts. Likewise, firms with a lack of structure and communication could positively or negatively influence change commitment, since there may be a perceived a lack of communication or commitment not based on the implementation, but based on previous experiences within the firm. Weiner contends that while these may influence positive or negative components of the model, they are in fact the results of prior experiences and conditions based on previous implementation efforts, not necessarily preconditions of future attempts.

III.4 Hypothesis Development

This section provides a short description of each ORIC context and the hypotheses defined by the relationships between the constructs. The relationships between variables are designated as positive or negative.

Change Valence

Organizations who place greater value on the change (change valence) are more likely to have higher levels of change efficacy and change commitment at $p<.05$.

H1: Change valence will positively influence efficacy.

H2: Change valence will positively influence change commitment.

Informational Assessment

Organizations who provide access to tools, time and resources are more likely to have higher levels of change efficacy and change commitment at $p<.05$.

H3: Informational assessment will positively influence change efficacy.

H4: Informational assessment will positively influence change commitment.

Organizational Readiness for Change

Change Efficacy

Organizations whose members believe they have capability to implement the change are more likely to have higher levels of change related effort at $p<.05$.

H5: Change efficacy will positively influence change related effort.

Change Commitment

Organizations whose members believe they are committed to implementing the change are more likely to have higher levels of change related effort at $p<.05$.

H6: Change commitment will positively influence change related effort.

IV RESEARCH METHODOLOGY

While technology developers may be moving at a rapid pace, and changes in legislative initiatives are moving to allow more driverless vehicles on our highways, the following question arises: Is the trucking industry ready for this change? Hence, our research question: What is the organizational readiness for the disruption caused by autonomous commercial vehicles? To study this question, we need to gain knowledge of how, and to what extent, the carriers are preparing for this coming disruption.

IV.1 Research Design

Due to the size of the population, survey methodology was selected to provide a broad context explanation of the readiness capabilities of the respondent organizations. Respondents must be currently working for a carrier in the position of dispatch manager or above. Number of tractors will be used as a surrogate measure for firm size. The unit of analysis is the organization. Respondents were invited to participate in a Qualtrics hosted survey through two channels: (1) applications LinkedIn and Facebook, and (2) panel level data administered by Qualtrics. We considered two statistical methods to analyze the data, regression modeling and PLS-SEM. Structural Equation Modeling (SEM) was chosen as the most effective method because of its ability to consider the structural and measurement models simultaneously (Hair et al., 2017). SEM is designed as a multivariate statistical method thst incorporates factor analysis and regression into a single process. Target sample size was 175 responses although based on the Hair et al., (2014) table, a sample size of 174 is suggested as a sufficient same size. The Soper online tool using the reverse square root method suggests a sample size of 164 (Soper 2017). Based on the gamma-exponential method (Kock and Hadaya 2016), the minimum sample size would be N=146. Using these parameters, a minimum sample size of 175 was chosen with assumptions for standard power (.8) and effect (.3) to find statistical significance at (.01).

IV.2 Instrument Design

Drawing on prior ORIC research from Shea et al., (2014) and Hannon et al., (2017) we developed the survey as shown in Table 4. The instrument is designed to garner the organizational perceptions for the independent variables of Change Valence, Informational Assessment, Change Commitment, Change Efficacy and finally the dependent variability Change Related Effort which reports to what level is change related behavior occurring at the firm.

Table 4: ORIC ACV questions

QUESTION#	Construct	QUESTIONS	Reference
7	Change Valence	Our organization feels driverless trucks are compatible with our values.	Shea et al 2014
8	Change Valence	Our organization needs driverless trucks.	Shea et al 2014
9	Change Valence	Our company believes driverless trucks will benefit our company.	Shea et al 2014
10	Change Valence	Our company believes it is necessary to implement driverless trucks.	Shea et al 2014
11	Change Valence	Our company believes driverless trucks will work.	Shea et al 2014
13	Informational Assessment	We know how much time it will take to implement driverless trucks.	Shea et al 2014
14	Informational Assessment	Our company knows what resources we need to implement driverless trucks.	Shea et al 2014
15	Informational Assessment	Our company knows what each of us has to do to implement driverless trucks.	Shea et al 2014
16	Informational Assessment	Our company has the time we need to implement driverless trucks.	Shea et al 2014
17	Informational Assessment	Our company has the expertise to implement driverless trucks.	Shea et al 2014

QUESTION#	Construct	QUESTIONS	Reference
18	Informational Assessment	Our company has the skills to implement driverless trucks.	Shea et al 2014
19	Informational Assessment	Our company has the resources we need to implement driverless trucks.	Shea et al 2014
21	Change Efficacy	Our company feels confident we can manage the organizational politics to support implementing driverless trucks.	Shea et al 2014
22	Change Efficacy	Our company can keep the momentum going to implement driverless vehicles.	Shea et al 2014
23	Change Efficacy	Our company is confident the organization can support people as they adjust to driverless trucks.	Shea et al 2014
24	Change Efficacy	Our company is confident we can coordinate tasks so that implementation of driverless trucks goes smoothly.	Shea et al 2014
25	Change Efficacy	Our company is confident we can handle the challenges arising from implementing driverless trucks.	Shea et al 2014
26	Change Commitment	Our company is committed to implementing driverless trucks.	Shea et al 2014
27	Change Commitment	Our company is determined to implement driverless trucks.	Shea et al 2014
28	Change Commitment	Our company is motivated to implement driverless trucks.	Shea et al 2014

QUESTION#	Construct	QUESTIONS	Reference
29	Change Commitment	Our company will do whatever it takes to implement driverless trucks.	Shea et al 2014
30	Change Commitment	Our company believes it needs to implement driverless trucks.	Shea et al 2014
31	Change Related Effort	Does your organization have established, written goals for implementation of driverless trucks?	Hannon 2017
32	Change Related Effort	Does your organization have a driverless truck coordinator?	Hannon 2017
33	Change Related Effort	Does your organization have a driverless truck committee?	Hannon 2017
37	Context	How has a previous attempt to implement new technologies or processes (e.g. electronic on-board recordings) gone at your carrier?	Hannon 2017
12	Distractor #1	The timing is good to implement this change	Shea et al 2014
20	Distractor #2	The timing is good for implementing driverless trucks.	Shea et al 2014

We included two distractor questions to check participant attention and diligence of the respondents (Shea et al., 2014). To understand the contextual environment at the firms, we asked two open ended questions and one Likert-like scale question concerning prior implementations and opinions on future implementations.

The questions form the basis for the model. The independent variables provide weights to the over arching constructs and are measured using a 5-point Likert-like scale (1=Strongly Disagree to 5+ Strongly Agree). The dependent variable (change related effort) requires a yes/no response and the value is derived from summing the three items and taking the mean (minimum possible score.0, maximum possible score.1). This is consistent with how previous studies have handled this variable (Hannon et al., 2017).

IV.3 Structural Equation Modeling

Structural Equation Modeling (SEM) is a method of data analysis often used in marketing research. It can test causal and linear theoretical models (Chin & Newell 1999, Ping 2002, Huang 2013, Sarsted et al., 2014, Ringle et al., 2014). It can utilize both exogenous as well as endogenous variables. Exogenous variables are not affected by other variables in the model and are considered independent of other variables. Endogenous variables derive their value from other variables within the model (Hair et al., 2017).

SEM was used in this study because of its ability to explore relationships between multiple unobserved as well as observed variables. While SEM is typically applied using CB-SEM or PLS-SEM, we chose PLS-SEM as the statistical method (Hair, Ringle and Sarstedt 2012). Based on the nature of the study being a small sample size, a model with many structural relationships among the variables and the ability to estimate the coefficients path to maximize the R-squared construct values (Hair et al., 2016, Ringle 2012), it was deemed PLS-SEM was the most appropriate method for data analysis.

Partial least squares (PLS) can trace its origins to 1982 and was the work of Herman Wold (Wold, H. 1982). There has been significant debate recently concerning the appropriateness of the PLS method for use in structural equation modeling (Antonakis, Bendahan, Jacquart and Lalive 2010, Ronkko & Evermann 2013, Ronkko, Mcintosh and Antonakis 2015). While we acknowledge this debate, there is ample evidence to suggest PLS-SEM as a valid statistical method of analysis when exploring the estimates of the relationships among constructs and indicators (Sarstedt et al., 2016, Haenlin and Kaplan 2004, Statsoft 2013, Lohmoller 1989, Ringle et al., 2005). Specifically, it is considered useful in theorizing in management based research (Hair et al., 2017 and Richter et al., 2016) with the following conditions:

- PLS-SEM should be used if the goal is determining target constructs or identifying "driver" constructs.
- PLS – SEM should be used in exploratory or as an added component of existing structural theory
- CB-SEM should be used if the goal is testing or confirming a theory or comparing alternative theories.

(source: Hair et al., 2011)

Since the purpose of our study was primarily an exploratory study using existing theory we chose PLS-SEM. We used Smart PLS3 as the modeling package for the data (Ringle et al., 2015).

IV.4 Model Validation

IV.4.1 *Formative Model Testing*

A measurement model can have reflective (Mode A) or formative (Mode B) constructs (Hair er.al, 2011). Reflective indicators are interchangable with the construct and removing one indicator does not necessarily change the construct. In the case of a formative measure the construct is a sum of its parts (indicators) and removing one indicator can dramatically change the meaning of the construct. We did not want to make an assumption concerning our model to determine whether it had Mode A or Mode B constructs. Instead, we tested the model for both formative and reflective constructs and used the existent literature to determine if the model was formative or reflective. The ACV model as formative is provided as Figure 6.

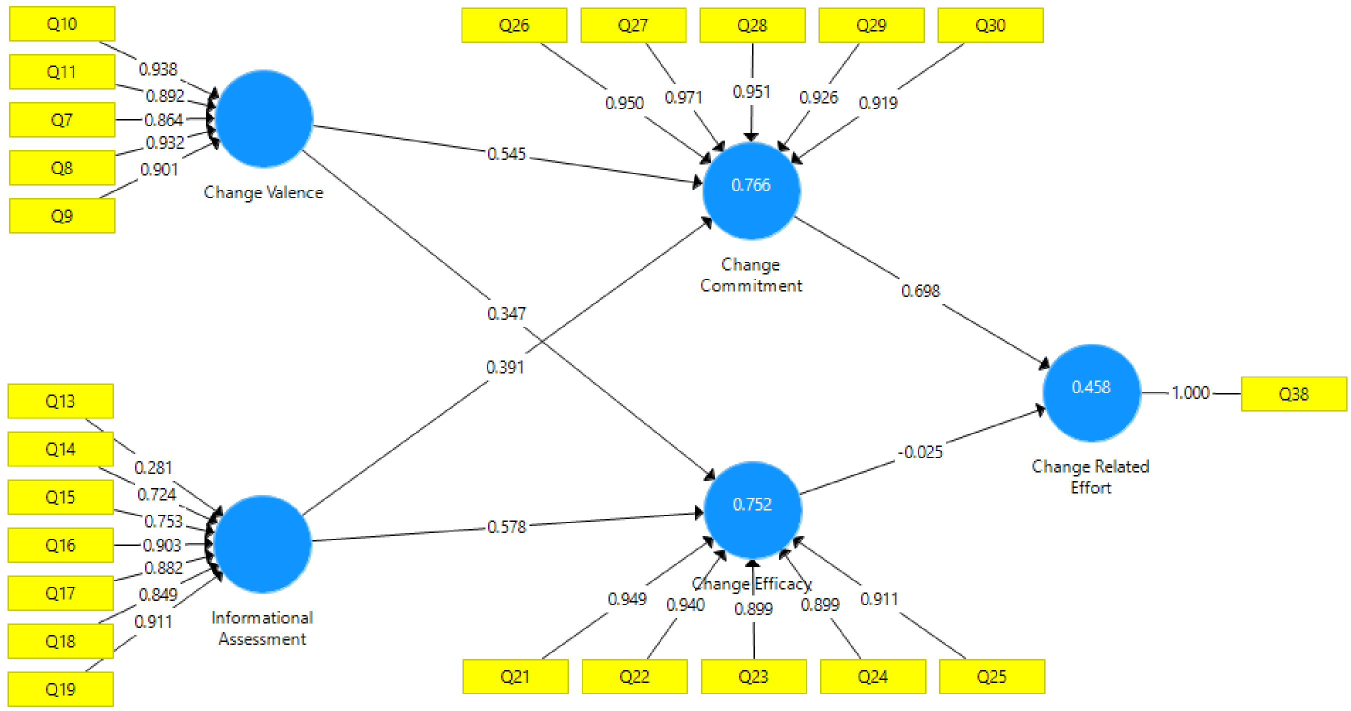

Figure 6: ACV model as Formative

When modeled as a formative model Change Valence, informational Assesment and Change Commitment demonstrated high degrees of collinearity as measured by their variance inflation factor scores (VIF's) indicating they could not be considered formative constructs as illustrated in Table 5. In the case of Change Commitment four of the five indicators were in excess of 5 (Q27,Q28,Q29,Q30) which is considered the threshold for collinearity (Hair et al., 2011).

Table 5: Formative Model VIF's (red indicated excess of 5)

Indicator	VIF	Indicator	VIF
Q7	2.94	Q19	3.11
Q8	4.33	Q21	**5.13**
Q9	**6.23**	Q22	4.81
Q10	**5.85**	Q23	4.81
Q11	3.26	Q24	**5.66**
Q13	1.37	Q25	4.35
Q14	3.56	Q26	4.67
Q15	3.91	Q27	**10.88**
Q16	3.04	Q28	**8.36**
Q17	**5.06**	Q29	**6.64**
Q18	**5.20**	Q30	**6.71**
		Q38	1

The presence of indicators with variance inflation factors in excess of 5 meant we would need to remove these from the study. Given the significant presence of these results in three of the variables, (change valence, informational assessment and change commitement), we deterined the model was in fact not formative. Since the results did not indicate the model was formative, we then tested the model as a reflective model.

V DATA ANALYSIS STRATEGY

V.1 Survey

This survey was designed to focus on a sample of individuals with the title of Manager or higher in commercial trucking companies based in the United States. The survey platform Qualtrics was used to host and collect the survey data. Participants were invited to take the study via email, and their participation was anonymous. A link to the survey was also posted on the LinkedIn and Facebook applications, and trucking group members were asked to complete the survey. This procedure reached 1,536 people and produced 28 responses between Nov. 6th, 2017 and Nov. 20, 2017 for a response rate of 1.85%. Qualtrics was contracted to provide panel level data, and this process began on Nov. 20th, 2017 and lasted until December 14, 2017. The panel level data produced 764 responses; 150 were completed for a response rate of 19.6%. The data gathering process lasted from Nov. 6th, 2017 until Dec. 14th, 2017 with 2300 respondents being contacted. One hundred and seventy-eight (N=178) provided completed responses for a combined response rate of 7.8%. The time required for completing the survey based on pilot testing was at least three minutes. With the minimum of three minutes from the test sample, participants who completed the survey in less than three minutes were excluded from further analysis.

V.2 Respondents

This study focuses on the supra-individual level. Shea et al., (2014) defines the supra-individual level as the team, department or organization. The sample size consisted of management level employees currently working for trucking companies located within in the United States. The respondents were asked about the characteristics and capabilities for their organization.

V.3 Data Cleansing

Participants were asked to provide their informed consent to participate and offered the opportunity to opt out of the survey at any time. Eight hundred and four respondents participated in the survey. Twelve were part of the pilot questionnaire and were removed from the final pool of surveys. Eighty-one respondents did not agree to provide their informed consent and were thanked for their participation and exited from the survey. Filters were placed in Qualtrics to ensure the sample met the criteria for the study. The filters included 1) the respondent must hold a management position 2) the respondent must be currently working for a trucking company. Twenty-nine respondents were not working in a management capacity, and 498 were not currently working for a trucking company; both groups were thanked for their participation and exited from the survey. Three respondents failed to complete the survey, and three completed the survey in less than three minutes; both groups were removed from the final pool. From the original 804 respondents, 178 remained. This process is illustrated in Figure 7.

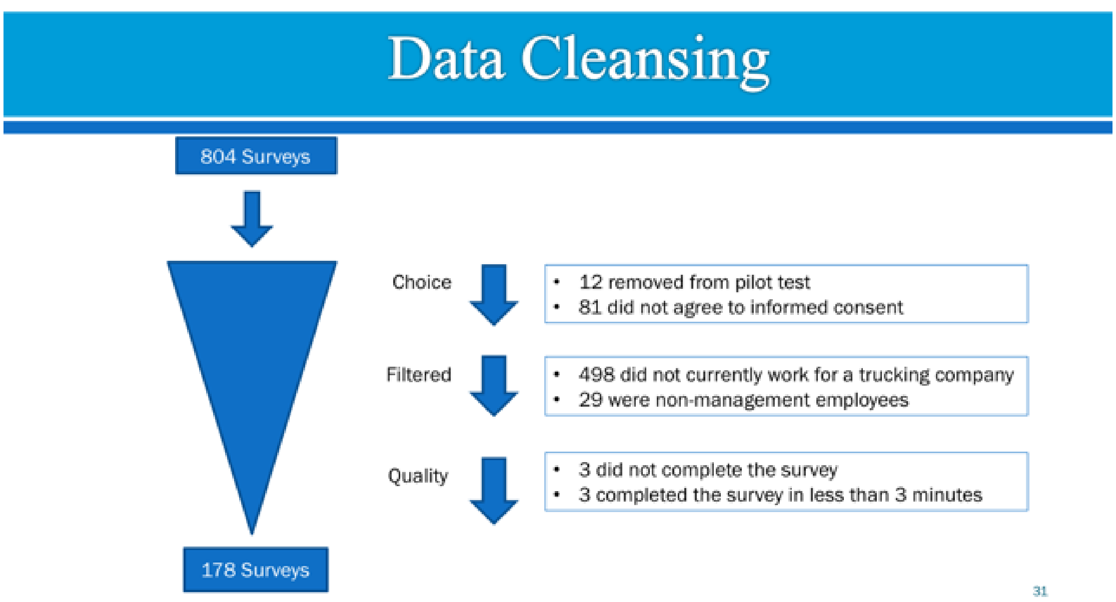

Figure 7: Data Cleansing

VI RESULTS

VI.1 Descriptive Statistics

As illustrated in Table 6, Age was determined by asking the participants to provide their year of birth. Questions 4 thru 6 were questions concerning the current firm size and service parameters. Questions 7 thru 11 were relating to the perception of change valence within the firm. Questions 13 thru 19 were an assessment of the informational capabilities of the firm. Questions 21 thru 25 were related to change effiacy perceptions and questions 26 thru 30 were concerning the change commitment of the firm. Questions 12 and 20 were distractor questions used to assess the attention and understanding of the participants towards the questions they were being asked.

Table 6: MEAN, MEDIAN AND STANDARD DEVIATION

Indicator	MEAN	MEDIAN	STANDARD DEVIATION
Q4 - Descriptive	3.61	4	1.17
Q5 - Descriptive	7.78	8	3.57
Q6 - Descriptive	4.61	3.5	3.64
Q7 - Change Valence	2.42	2	1.33
Q8 - Chage Valence	2.36	2	1.33
Q9 - Change Valence	2.48	2	1.37
Q10 - Change Valence	2.39	2	1.32
Q11 - Change Valence	2.63	2.5	1.41
Q12 - Distractor	2.42	2	1.31
Q13 - Informational Assessment	2.07	2	1.19
Q14 - Informational Assessment	2.52	3	1.24
Q15 - Informational Assessment	2.55	2	1.31
Q16 - Informational Assessment	2.55	2	1.34
Q17 - Informational Assessment	2.55	2	1.38
Q18 - Informational Assessment	2.69	3	1.42

Q19 - Informational Assessment	2.58	2	1.37
Q20 - Distractor	2.43	2	1.28
Q21 - Change Efficacy	2.71	3	1.32
Q22 - Change Efficacy	2.62	3	1.29
Q23 - Change Efficacy	2.78	3	1.34
Q24 - Change Efficacy	2.74	3	1.35
Q25 - Change Efficacy	2.85	3	1.36
Q26 - Change Commitment	2.48	2	1.33
Q27 - Change Commitment	2.35	2	1.36
Q28 - Change Commitment	2.44	2	1.41
Q29 - Change Commitment	2.29	2	1.33
Q30 - Change Commitment	2.46	2	1.38
AGE	42.63	41.5	10.6
Q38 - Change Related Effort	0.19	0	0.34

The average age of the repondents as expressed Table 7 was 42.63 years. Considering we limited the respondents to those who held management positions in trucking companies, this is consistent with what we expected to find. According to industry sources the average age of tranpsortation, storage and distribution managers is 44.6 (Data USA 2018) which indicates our sample respondents are in line with previous studies of the industry.

Table 7: Age of respondents

Characteristics	Sample N= 178
Age	Years
Mean	42.63
Median	41
Standard Deviation	10.6

When firm size is measured by number of terminals the majority of the respondents report operating less than five terminals (63%), see Table 8. While 37% percent have more than six terminals. The vast majority of participants have less than 20 trucks, which would correspond to one or two terminals. Therefore, the study participants represent larger firms than is respresentative of the industry as a whole. Most snapshots of firm size consider number of trucks to be indicative of fleet size. We will discuss these findings based on terminal size more in the following chapters as this information may prove useful for implementation of driverless technologies.

Table 8: Firm size

Firm Size	Trucks	Terminals
1-5	23%	63%
6-10	12%	12%
11-50	22%	13%
51-100	11%	2%
Over 100	32%	10%

According to industry statistics the average size of a trucking fleet is small and the industry is fragmented. Over 90% have less than 20 trucks (ATA 2015, Costello 2013). The respondent pool for this study included larger carriers than is an industry norm. Forty-three percent of our respondents had more than 50 trucks in their fleets as illustrated in Table 9. This indicates larger organzitional structures within the sample pool than the industry norm; this should be reflective of more developed organizational structures than the average carrier. If the results of the study indicate the organizations are ready for driverless trucks, this fact should be considered as a possible limitation. Consequently, if, on the other hand, this study indicates there is a lack or readiness based on the sample pariticpants this could mean the organizations on the whole could actually be less ready than this study indicates. This is assuming size could be a factor in determining readiness as more developed organziational infrastructures could support more advanced planning, preparation and change related effort for disruptive change effects.

Table 9: Participant by Geography

Geography	Study	Industry Average
Northeast	20%	17%
Southeast	37%	34%
Midwest	16%	25%
West	28%	24%
Total	100%	100%

Ref: Magoci 2016

Based on a reports of industry averages for fleet origins (Magoci 2016), our study is consistent with industry averages with the exception of the midwestern states. Our study sample has a slightly lower participation from organizations in the midwest than would be expected based on the averages from the industry as demonstrated in Table 9. This difference is made up by a slightly larger participation of carriers from the other three regions. This insures one region is not overly affecting our results and should provide a representative sample of all the regions when taken together.

Change Related Effort

The respondents were asked the following three questions related to change related effort occurring at their fim:

Does your organization have established, written goals for implementation of driverless trucks? 141 of the 178 (79%) responded NO.

Does your organization have a driverless truck coordinator? 151 of the 178 (85%) responded NO.

Does your organization have a driverless truck committee? 143 of the 178 (80%) responded NO.

130 of the 178 (73%) carriers responded NO to all three change related effort questions indicating no change related effort is taking place at almost 3/4 of the carriers.

VI.2 Model Validation

In the intitial ACV model (Figure 8) we present the model along with the corresponding factor loading for each indicator comprising the constructs. Factor loadings less than .7 do not meet the standards of a reflective construct (Hair et al., 2017). One indicator Q13 failed to meet a loading of .7 (Q13 = .40) and was removed. In a reflective model removing one indicator does not necessarily change the construct as the indicators are considered interchangable (Hair et al., 2017).

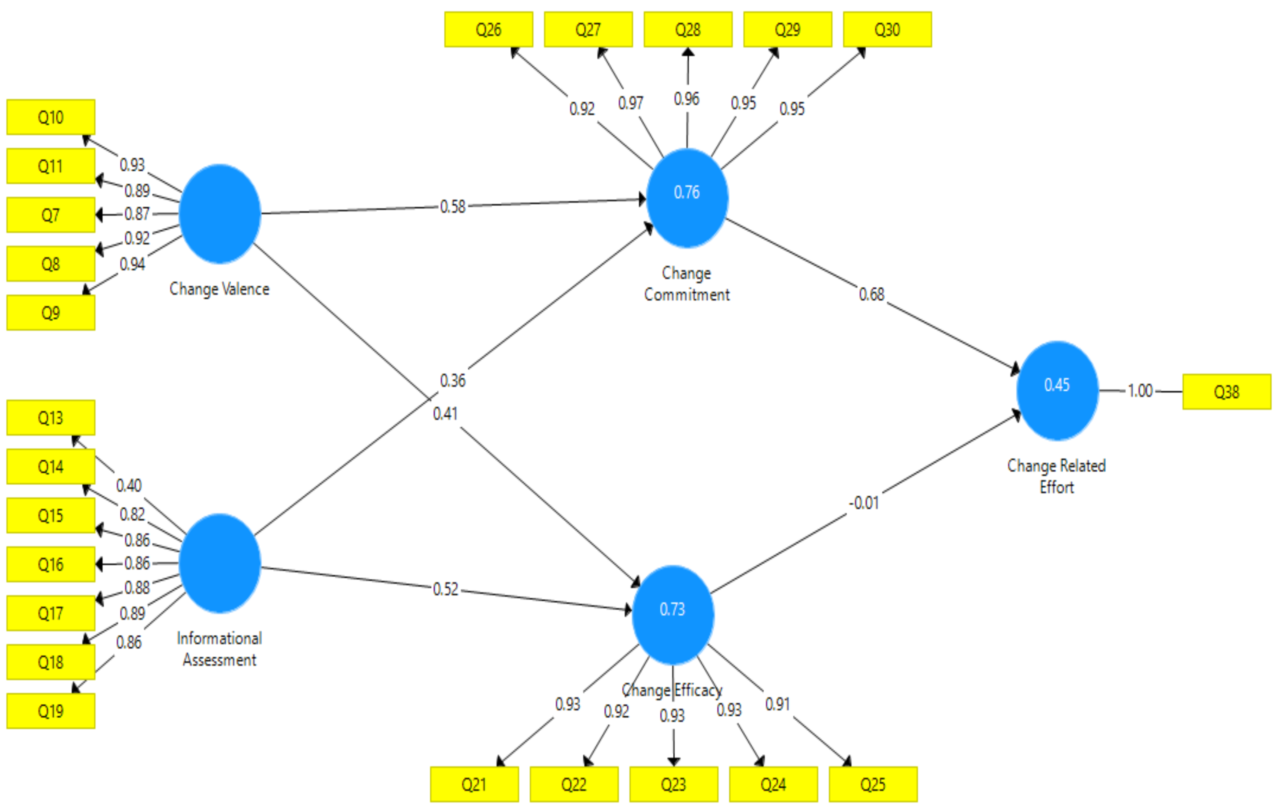

Figure 8: Figure 7: Data Cleansing

This produced a new model as expressed by Figure 8 which exhibits all factor loadings in excess of .7 (Hair et al., 2017). Multi Collinearity testing was done for the constructs and all five were below 5 as illustrated in Table 10 (Hair et al., 2017), which indicate there was no issue with multi collinearity: again validating our model as a reflective model. Therefore, we determined our model and all corresponding indicators were reflective (Mode A).

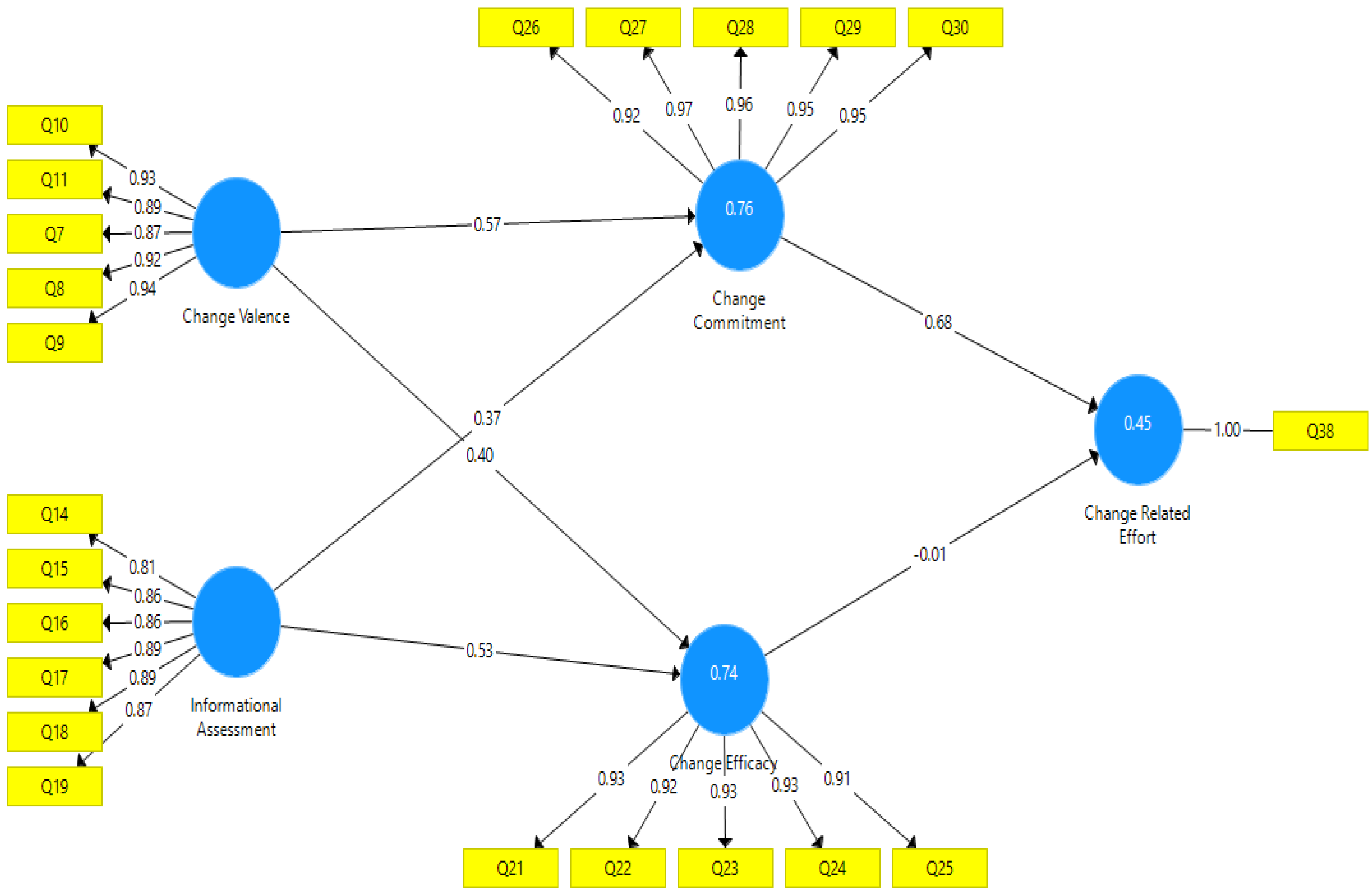

Figure 9: Adjusted ACV Model

Table 10: Muli-Collinearity Result - Constructs

	Change Commitment	Change Efficacy	Change Related Effort
Change Commitment			3.671
Change Efficacy			3.671
Change Related Effort			
Change Valence	1.924	1.924	
Informational Assessment	1.924	1.924	

VI.3 Construct Testing

VI.3.1 *Convergent Validity – Outer Loadings/Cronbach-Alpha*

We then tested for convergent validity by evaluating the outer loadings of the indicators and all indicators were in excess of .7 which was acceptable (Hair et al., 2017). The results of this test are illustrated in Table 11.

Table 11: Convergent Validity

	Change Commitment	Change Efficacy	Change Related Effort	Change Valence	Informational Assessment
Q10				0.93	
Q11				0.89	
Q14					0.81
Q15					0.86
Q16					0.87
Q17					0.89
Q18					0.90
Q19					0.87
Q21		0.93			
Q22		0.92			
Q23		0.93			
Q24		0.94			
Q25		0.91			
Q26	0.92				
Q27	0.97				
Q28	0.96				
Q29	0.95				
Q30	0.95				
Q38			1.00		
Q7				0.87	
Q8				0.92	
Q9				0.94	

To further test the convergent validity we also ran the Cronbach Alpha to measure internal consistency. A coefficient of .7 or greater indicates we have acceptable internal consistency (Hair et al., 2017). All indicator coefficiencts exceeded the .7 threshold for Cronbach Alpha therefore we have internal consistency in the model. The results of the Cronbach Alpha are reported in Table 12.

Table 12: Convergent Validity - Cronbach Alph/AVE

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Change Commitment	0.97	0.97	0.98	0.90
Change Efficacy	0.96	0.96	0.97	0.86
Change Related Effort	1.00	1.00	1.00	1.00
Change Valence	0.95	0.95	0.96	0.83
Informational Assessment	0.91	0.94	0.93	0.66

VI.3.2 *Discriminant Validity*

Discriminant validty tests that the indicators that are not supposed to be related are in fact unrelated. To test for discriminat validity we used Heterotrait-Monotrait ratios of correlations (HTMT) (Henseler, J., Ringle, C. M., and Sarstedt, M. 2015) and Fornell-Larcker (Hair et al., 2017).

Using the HTMT criterion, we are said to have discriminate validity if the results are less than .9 (Henseler, J., Ringle, C. M., and Sarstedt, M. 2015). All of our constructs are below the .90 threshold, therefore based on the analysis using HTMT we have discriminant validity. The results are shown in Figure 9.

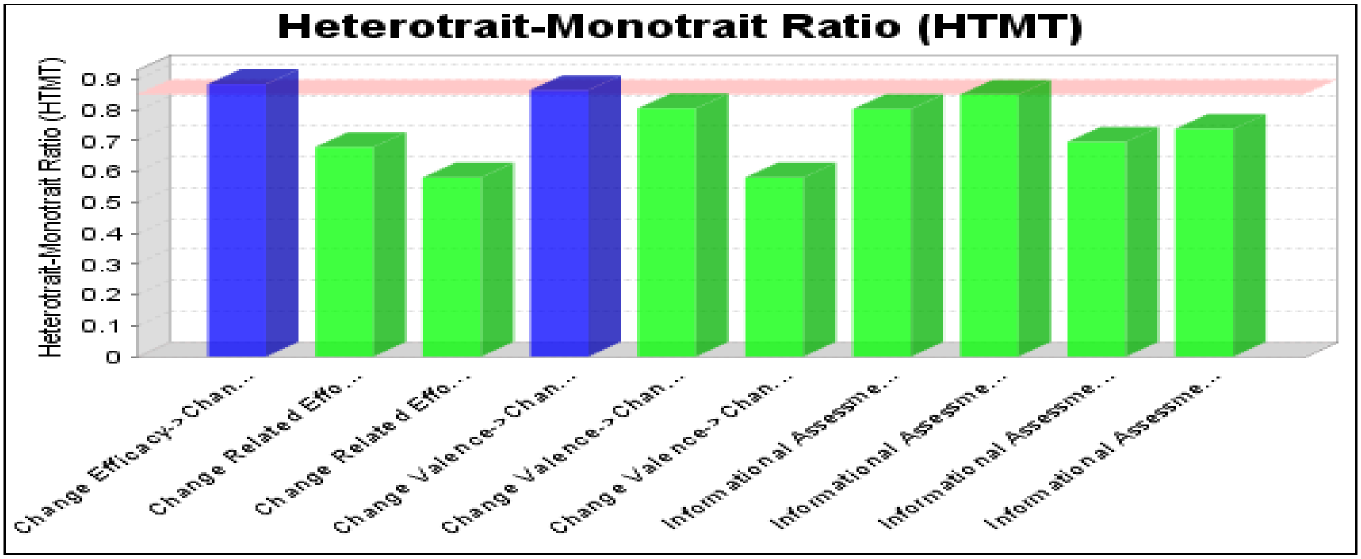

Figure 10: Discriminant Validity - HTMT

The results for Fornell-Larckerr should demonstrate that the square root of each construct's AVE should have a greater value than the correlations with other constructs (Bollen 1989). All of the correlations for the model meet the criteria and, therefore, based on testing via HTMT and Fornell-Larcker we have discriminant validity in our measurement model. Likewise, we performed Variance Inflation Factor (VIF) testing on the constructs to test for multi-collinearity. We combined the results of the Fornell-Larcker and VIF testing into Table 13. All VIF's are below 5, which is the threshold for multi-collinearity testing: therefore we do not appear to have multi-collinearity between the constructs (Hair et al., 2017).

Table 13: Discriminant Validity – Fornell-Larcker/Variance Inflation Factors

	Change Commitment	Change Efficacy	Change Related Effort	Change Valence	Informational Assessment
Change Commitment	0.949		3.67	1.941	1.941
Change Efficacy	0.853	0.926	3.67	1.941	1.941
Change Related Effort	0.67	0.569	1		
Change Valence	0.831	0.768	0.565	0.911	
Informational Assessment	0.768	0.809	0.673	0.696	0.864
Multi Collinearity test results (VIF's) in yellow					

VI.4 Path Analysis

After validating the measures, we move to testing the structural model. We performed this analysis in two steps. Step one was to test the measurement model, including bootstrapping, testing the outer loadings with P values and significance, and, the inner measurement model T statistics and P values. In step two, we tested the structural mode. We tested for latent variable correlations, direct effects, indirect effects, total effects, R squared, model fit, and Stone Geisser Q- squared (Blindfolding). This two-step process provided us the findings from which are able to draw conclusions about the model, the constructs and their effects.

VI.5 Measurement Model

Bootstrapping – Bootstrapping is a nonparametric method that allows testing of the statistical significance of various PLS-SEM results such as path coefficients and R^2 values (Davison & Hinkley, 1997; Efron & Tibshirani, 1993). Using this method, a large number of sub-samples are created (Hair et al., 2017). These sub-samples are estimations of the model. Additionally, these sub-samples provide for the estimation of standard errors of the model. This process allows the researcher to p-values, t-values and confidence intervals which allow for the testing of statistical significance of the results. For this study, 5000 subsamples were constructed, with parallel processing, no sign changes, basic bootstrapping and confidence intervals set to bias-corrected and accelerated (BCa) bootstrap for a two-tailed test at a 5% significance level.

VI.5.1 *Outer loadings with P-Values and Significance*

The results of the outer loadings with P-Values and signficance are shown in Table 14. All of the indicators have a P-Value of less than .01 which indicates they are significant (Hair et al., 2017).

Table 14: Outer Loadings/P-values

Indicators	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Q10 <- Change Valence	0.93	0.93	0.02	53.80	p<.01
Q11 <- Change Valence	0.89	0.89	0.02	38.62	p<.01
Q14 <- Informational Assessment	0.81	0.81	0.04	20.78	p<.01
Q15 <- Informational Assessment	0.86	0.86	0.03	30.36	p<.01
Q16 <- Informational Assessment	0.87	0.87	0.02	36.88	p<.01
Q17 <- Informational Assessment	0.89	0.89	0.02	53.63	p<.01
Q18 <- Informational Assessment	0.90	0.90	0.02	55.98	p<.01
Q19 <- Informational Assessment	0.87	0.87	0.02	41.48	p<.01
Q21 <- Change Efficacy	0.93	0.93	0.01	83.47	p<.01
Q22 <- Change Efficacy	0.92	0.92	0.01	65.81	p<.01
Q23 <- Change Efficacy	0.93	0.93	0.01	73.51	p<.01
Q24 <- Change Efficacy	0.94	0.94	0.01	86.35	p<.01
Q25 <- Change Efficacy	0.91	0.91	0.02	46.05	p<.01
Q26 <- Change Commitment	0.92	0.92	0.02	59.75	p<.01
Q27 <- Change Commitment	0.97	0.97	0.01	114.65	p<.01
Q28 <- Change Commitment	0.96	0.96	0.01	109.35	p<.01
Q29 <- Change Commitment	0.95	0.95	0.01	104.28	p<.01
Q30 <- Change Commitment	0.95	0.95	0.01	113.93	p<.01
Q38 <- Change Related Effort	1.00	1.00	0.00		
Q7 <- Change Valence	0.87	0.87	0.03	26.51	p<.01
Q8 <- Change Valence	0.92	0.92	0.01	74.32	p<.01
Q9 <- Change Valence	0.94	0.94	0.02	58.72	p<.01

VI.5.2 *Inner Measurement Model T Statistics and P Values*

The results of the inner loadings with P-Values and signficance are described in Figure 10. The model has a P-Value of less than .01 for the path with the exception of change efficacy to change related effort which has a p-value of .93 which is in excess of the .05 test for signifiance.

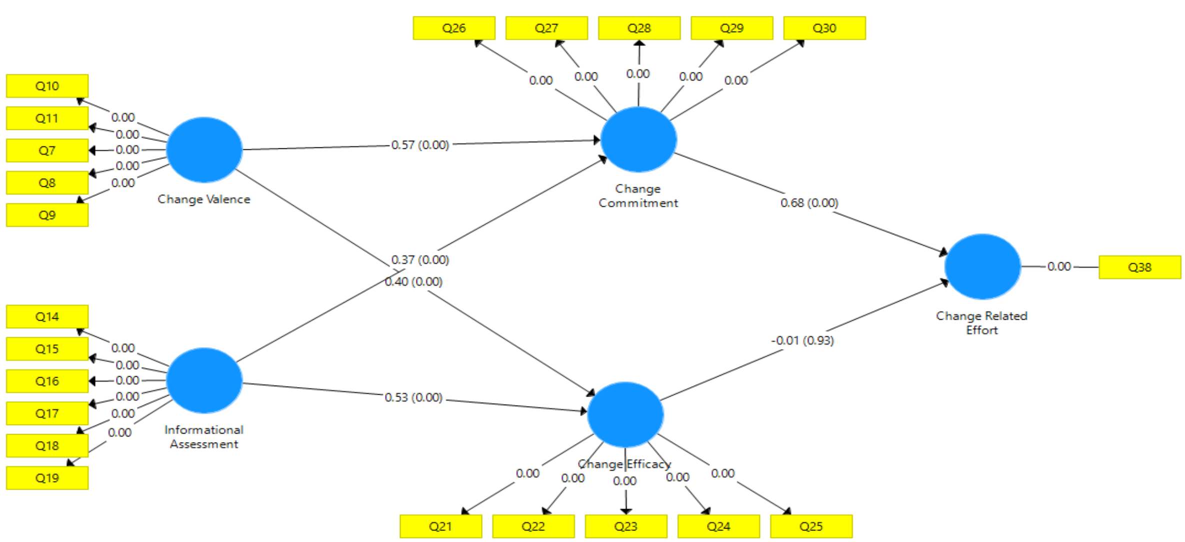

Figure 11: Inner Measurement Model with P-values

VI.6 Structural Model

To evaluate the structural model, we performed analysis using a variety of tools available in Smart PLS3. The results of this analysis are demonstrated below.

VI.6.1 *Latent Variable Correlation* –

A latent variable correlation was performed and the results are shown in Table 15. The Latent Variable correlations .1 or less signifies a low correlation, .1 to .5 indicates medium level of correlation, and .5 or greater illustrates a large correlation (Hair et al., 2017). All correlations are in excess of .5 indicating a large correlation for the model.

Table 15: Latent Variables

	Change Commitment	Change Efficacy	Change Related Effort	Change Valence	Informational Assessment
Change Commitment	1.00	0.85	0.67	0.83	0.77
Change Efficacy	0.85	1.00	0.57	0.77	0.81
Change Related Effort	0.67	0.57	1.00	0.57	0.67
Change Valence	0.83	0.77	0.57	1.00	0.70
Informational Assessment	0.77	0.81	0.67	0.70	1.00

VI.6.2 *Direct/Indirect Effects* –

Direct effects were measured by running a path coefficient analysis of the path. Indirect effects were measured by performing a path analysis of the constructs not directly in the path of the dependent variable, change related effort. The results for both the direct and indirect effects are reported in Table 16. The results of this direct effect analysis demonstrate that change commitment is responsible for 67% of the variance in change related effort. The results of the indirect effects shows that 39% of the variance of change related effort can be explained by change valence while 24% can be explained by informational assessment.

Table 16: Direct and Indirect Effects

	Change Commitment	Change Efficacy	Change Related Effort
Change Commitment			0.68
Change Efficacy			-0.01
Change Related Effort			
Change Valence	0.58	0.40	0.39
Informational Assessment	0.37	0.53	0.24

VI.6.3 ***Dependent Variable Variaton***

R-Squared – The results of the R-Squared and R-Squared adjusted are illustrated in Table 17. R-Squared measures the percentage of variation in the dependent variable that can be explained by the independent variables. Adjusted R-squared accounts for the number of independent variables in its calculation and adjusts the R-squared accordingly. Change commitment has an adjusted R- Square of .76 therefore, seventy-six percent of the variation in change related effort can be explained by change commitment, and the results are statistically significant. Therefore, change commitment is a very strong predictor of change related effort.

Table 17: R-Squared

	R Square	R Square Adjusted
Change Commitment	0.76	0.76
Change Efficacy	0.74	0.73
Change Related Effort	0.45	0.44

VI.6.4 ***Model Fit –***

Model fit attempts to measure the correlation between the implied model and the empirical correlation matrix (Byrnes 2008). The standardized root mean square residual is used to determine the fit (Hu and Bentler 1999). A fit of .08 or lower is considered acceptable. The results of the model fit are reported in Table 18, and the SRMR for the model is .05, which is below the threshold; therefore, the model is considered a good fit.

Table 18: Model Fit

	Saturated Model	Estimated Model
SRMR	0.05	0.06
d_ULS	0.57	0.96
d_G1	1.00	1.09
d_G2	0.68	0.76
Chi-Square	656.72	710.42
NFI	0.88	

VI.6.5 *Predictive Relevance*

The Stone-Geisser's Q^2 value was used to measure the predictive relevance of the model (Hair et al., 2017). Q^2 values, which are estimated by "blindfolding" in PLS-SEM. The blindfolding process signifies how well the path model is able to predict the originally observed values (Hair et al., 2017). For this analysis, we used 7 cases and the construct cross-validated redundancy approach to evaluate the model. Q^2 values near 0.02 implies small, values near 0.15 implies medium, and over 0.35 suggest large predictive relevance for a specified endogenous construct (Hair et al., 2017). The results of this process indicate the model has large predictive relevance as shown by Table 19.

Table 19: Predictive Relevance

	SSO	SSE	Q^2 (=1-SSE/SSO)
Change Commitment	890	322.93	0.64
Change Efficacy	890	367.45	0.59
Change Related Effort	178	100.68	0.43
Change Valence	890	890.00	
Informational Assessment	1,068.00	1068.00	

VI.6.6 *Context*

In addition to the questions we asked concerning firm readiness, we also ask respondents two open ended questions and one Likert-like question to understand the the contextual environment of their firm:

The Likert-like question was a seven point scale ranging from 1= extremely negative to 7= extrememly positive.

Question - *How has a previous attempt to implement new technologies or processes (e,g, electronic on-board recordings) gone at your carrier?*

The results of this question produces a mean of 4.40, a median of 5 and a standard deviation of 1.78. The results indicate the respondents have a neutral to slightly positive opinion of previous attempts to implement new technologies at their firm. The coefficient of variation is .38 which indicates there is low variation in the responses (Hair et al., 2017). These responses are meaninful as it pertains to the contextual environments of the firms. Respondents who have a moderate to positive feeling about prior attempts at new technology impementations should have a more positive opinion of their firms abilitiy to implement a new technology than those who feel there has been less success with prior implementations (Weiner 2009).

Question - *Given your experience and expertise, what should your company do to prepare for the disruption of driverless trucks?*

As a group, seven major themes constituted the responses. These themes are presented in Table 20.

Table 20: Themes for Industry Preparation

Issue	Count	PCT	Quote	Quote
Safety	55	31%	The fact that they are dangerous and unsafe.	The innocent motorists who will be killed by them
Complexity	32	18%	The customers! At any moment customers and agents change pickup and deliveries. A driverless truck will not be able to give that customer the care they need and want. And A driverless truck can not make them ajustments	Making deliveries to homes . Every stop is different
Did not respond	26	15%		
Acceptance	25	14%	Our business requires interaction with drivers that we don't know how to change	Just don't think they would work
Technology Lacking	17	10%	I think the capability of driverless truck technology is not where it is needed to be yet. The technology needs more testing before large scale implementation is feasible,	Having glitchless driverless technology so that the trucks will be safer without drivers than with.
Job Loss	16	9%	It will put people at risk for unemployment	reducng personnel does not make a good for the country
Cost	7	4%	Getting the money and patience	Cost
Total	178	100%		

Safety and Complexity were the two largest concerns or themes. The managers expressed concerns related to technological issues as well as the complicated nature of the trucking transaction over and above the driving of the truck. This opinion can be found in some of the sample responses below:

A thirty-eight year old Vice President from Alabama whose company operates between one hundred and two hundred and ninety nine trucks responded

"There are a lot of challenges that are involved in a driverless truck. Pre/post-trip inspections, fixing small issues on trucks and trailers, backing, opening doors on the trailers are just a few that come to mind."

Additionally, a 39-year-old manager from Pennsylvania whose company operates between fifty one and 99 trucks states,

"How will driverless trucks carry out communications with staff at the various facilities we service? Can there be autonomy in vehicular customer service? How can autonomous trucks interface with the task that only a human can handle? Driverless trucks cannot retrieve products without human intervention".

And finally, a thirty-eight-year-old dispatcher from Georgia whose company operates between twenty-one and 50 trucks responded, *"Getting the trucking companies and the shippers to work together. Without the shippers it doesn't matter if the trucks are driverless or not"*

There is significant concern among the participants that even if the technology develops capabilities to perform the driving task, there will still be challenges related to interaction with customers and shippers. That may be the reason so many of the respondents have concerns their company would accept the technology.

Question - *Given your experience and expertise, what should your company do to prepare for the disruption of driverless trucks?*

Four significant themes constituted the responses to this question. These themes are presented in Table 21.

Table 21: Themes for Company Preparing

Challenge	Count	PCT	Quote	Quote
Did not respond	50	28%		
Wont Accept	46	26%	We will never use these things	We make deliveriees to homes every stop has its challenges driverless trucks will never work
Research	46	26%	Better understand the technology and liabilities/risk	Our company needs more information
Planning	36	20%	We wll continue on with business as usual until the HUGE players in the industry have worked out the kinks. We will keep a close eye on the technology, the problems, the successes and failures, etc. We will study the evolution of driverless trucks and plan for a	Start educating employees now!!!
Grand Total	178	100%		

A thirty-year-old dispatch manager from Wisconsin responded,

"Just not support it. Not only will it probably cost more for new trucks but it comes with a boat load of problems. Not to mention put many many drivers out of work".

A sixty-five-year old Manager from Colorado responded:

"I believe it is too early to tell because we just (don't) have enough information out to the trucking industry's general population yet, I believe there is a lot of conversations that have to be had with the shippers, receivers, and the trucking industry yet".

Some participants believe the larger carriers should take the lead in the initiative and over time their experience will trickle down to some of the smaller fleets.

As an example: A fifty-eight-year old dispatcher from Texas state,

<u>"We will continue on with business as usual until the HUGE players in the industry have worked out the kinks. We will keep a close eye on the technology, the problems, the successes and failures, etc. We will study the evolution of driverless trucks and plan for a later adoption."</u>

Trucking companies have defined processes and procedures for roles within the firms, this includes managers and drivers. Given the respondents familiarity with their existing firms processes and procedures, it is worth noting the respondents seem to try interject the driverless technology into the current process. This appears to be a difficult leap for the participants to make given their current firms' structure.

While 73% of the respondents did not have change related effort occurring 27% did have some level of effort occurring. Given the technology is not available to the commercial market and yet over one quarter of the participants have change related effort occurring this can be viewed as participants believing this technology will one day soon be available. In order to look closer and see if the presence or lack of change related effort may influence some of these respondents, a subset of the original sample was created to include only those companies who have change related effort occurring at their firm, these results are reported in Table 22.

Table 22: Themes from firms with Change Related Effort

Theme	Count	PCT
Plan	20	42%
Don't know	16	33%
Research/Training	7	15%
Won't accept	5	10%
Grand Total	48	100%

Planning plays a much more significant theme to those respondents who have change related effort occurring at their organization. A forty-three-year old dispatcher from Washington summed up this concern by stating, *"Start small, proving the technology is a benefit to our customers. With even partial implementation of driverless trucks, there will be a backlash of current over the road drivers that will lead to some lost time and affect to loads leaving until the switch is accomplished".*

However, even with effort occurring at their firms, 43% did not answer what their firms need to do. Either the individual participants do not understand what is required, or there is scant evidence to them that this is a pressing issue within their firms to warrant concern. This finding may prove significant when other participants in the trucking eco-system attempt to roll out driverless technology applications over the next few years. This either lack of interest or lack of knowledge could prove problematic when the industry participants are approached concerning this technology. Understanding the positional awareness of the industry could prove useful to those tasked with implementing driverless solutions from both a technological as well as a policy perspective.

Fear of the unknown also seems to be prevalent, which may explain some of the concerns expressed as "will not accept" or "unknown" themes. Those respondents who did take the time to respond expressed significant concerns with their firms' ability to implement driverless trucks. This is consistent with findings from the ACV model as no change related effort is occurring at many firms.

A fifty-nine-year old manager from Florida responded;

"I truly do not know. The thought of driverless trucks terrifies me".

This fear or resistance to accept, whether they are related to trucking or not, will be a major impediment to implementation of driverless technologies.

VI.6.7 *Hypothesese Results*

The table below, Table 23, reports the results of the tests for the study hypotheses. All were supported, and the results were significant at P<.01 with the exception of the hypothesis

(H5) change efficacy positively influencing change related effort that was not supported. Given the other areas of the model provide such statistically significant results, we must examine further why change efficacy does not meet our hypotheses criteria. We will discuss this more in later chapters.

Table 23: Hypothesis Testing Results

Construct	Label	Hypotheses	Results	Significance
Change Valence	H1+	Change valence will positively influence change efficacy.	.58	P<.000
Change Valence	H2+	Change valence will positively influence change commitment	.37	P<.000
Informational Assessment	H3+	Informational assessment will positively influence change efficacy.	.53	P<.000
Informational Assessment	H4+	Informational assessment will positively influence change commitment.	.40	P<.000
Change Efficacy	H5+	Change efficacy will positively influence change related effort.	-.00	.943
Change Commitment	H6+	Change commitment will positively influence change related effort.	.68	P<.000

VI.6.8 *Model Consideration*

While the model passes the standard tests for reliatbility as well as discriminat and convergent validity there is a concern given the high correlation among the latent variables. For instance when the data is analyzed as described with Change Commitment and Change Efficacy separately Change Efficacy does not have statistical support. However, if Change Commitment is removed and only Change Efficacy is considered then it becomes supported and statistically significant. This is illustrated in Figure 11. When Change Commitment is removed then Change Effiacy explains 57% of the variance in Change Related Effort and is statistically significant.

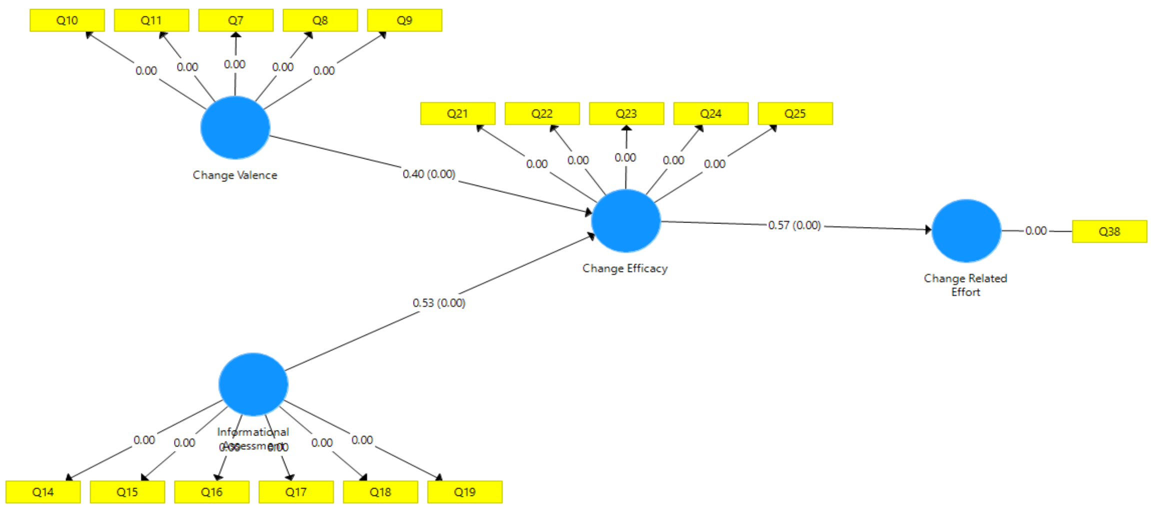

Figure 12: Model with just Efficacy

The variance inflation factors within the model do not indicate and issue, however this factor only analyzes the correlations between the explanatory variable in the model. The respondents appear to be interpretting Change Commitment and Change Efficacy as the same variable. In the original model proposed by Weiner, 2009 grouped Change Commitment and Change Efficacy into one variable called Organizational Readiness for Change. In later research by Shea et al., 2014 and Hannaon et al., 2017 the variables have been measured separately. It is interesting to note the results from the Hannon study also did not indicate support for Change Efficacy as a relaible measure. Drawing on the prior research of Weiner 2009 and the results of our study relative to the findings lacking significance for individual variable interpretations we propose to return to the original model as expressed in the original theory and combine Change Related Effort and Change Commitment into one combined variable Organizational Readiness for Change (“ORC). The results of this model are illustrated Figure 12.

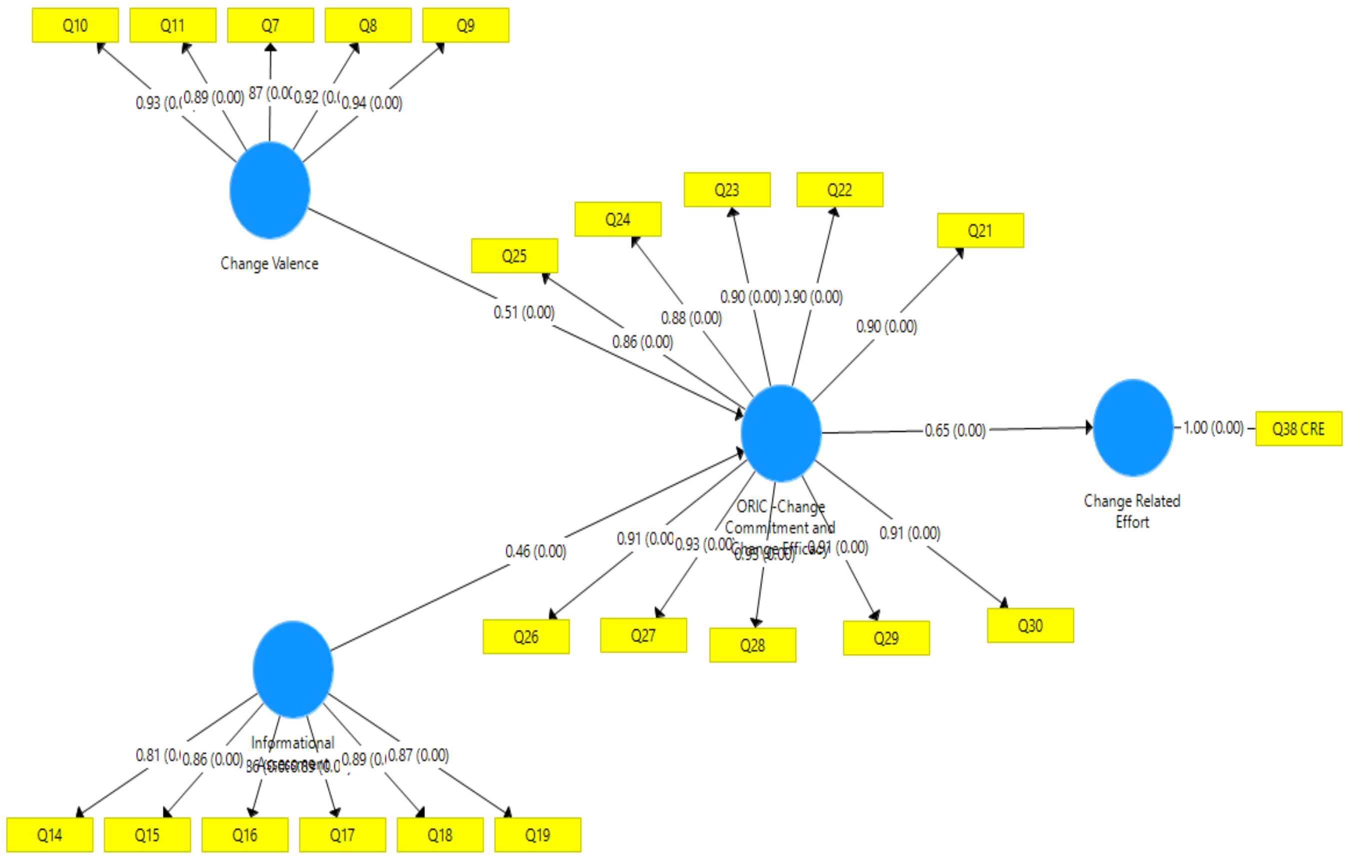

Figure 13: ORC Model

The combined variable explains 65% of the variation in Change Related Effort and is statistically significant. The validation of this new model is included in Table 24 and demonstrates the testing meets the standards as previously used in the study. This indicates the ORC model is a model of Organizational Readiness to Implement Change that may provide insight into the issues illustrated by Hannon et al., 2017 relative to the lack of statistical support for Change Efficacy.

Table 24: ORC Model Testing

Test	Results	Implications	Source
CONVERGENT VALIDITY	Results	Outcome	
Outer Loadings	all greater than .7	Passes	Hair et al., 2017
Cronbach-Alpha	all greater than .7	Passes	Kline 2000
DISCRIMINATE VALIDITY			
Fornell-Larcker	all greater than .5	Passes	Hair et al.,2015
HTMT	all below .9	Passes	Teo et al., 2008
MEASUREMENT MODEL			
Inner Model Vif's	all below 5	Passes	Hair et al., 2015
Outer Loadings	all have p value less than .01	Passes	Hair et al., 2015
Latent Variable Correlation	all greater than .5	Passes	Hair et al., 2015
Total Effects	ORC has an effect of 65% on CRE	65% of the effect on CRE is due to ORC	Hair et al., 2015
R-Squared Adjusted	ORC has an Adjusted R-Square of 80%	ORC explains 80% of the variance in CRE	Hair et al., 2015
Model Fit	Estimated Model fit of .06	Below .08 is considered a good fit	Hair et al., 2015
Bindfolding	61%	61% of the predicted relevance of CRE can be explained by ORC	Hair et al., 2015

80% of the variance of CRE can be explained by ORC based on the R-square of .80 while 61% of the explained variance in CRE can be explained by ORC. This indicates the model has strong predictive capabilities.

VI.6.9 *Controls*

In addition to the testing of the model itself the study also investigated whether certain contextual variables could have an impact on Informational Assessment and Change Valence. In the case of size, as measured by number of terminals, the results demonstrated an effect that was statistically significant. This is illustrated in Figure 13. 26% of Change Valence and 28% of Informational Assessment can be explained by the number of terminals an organization has and both are statistically significant.

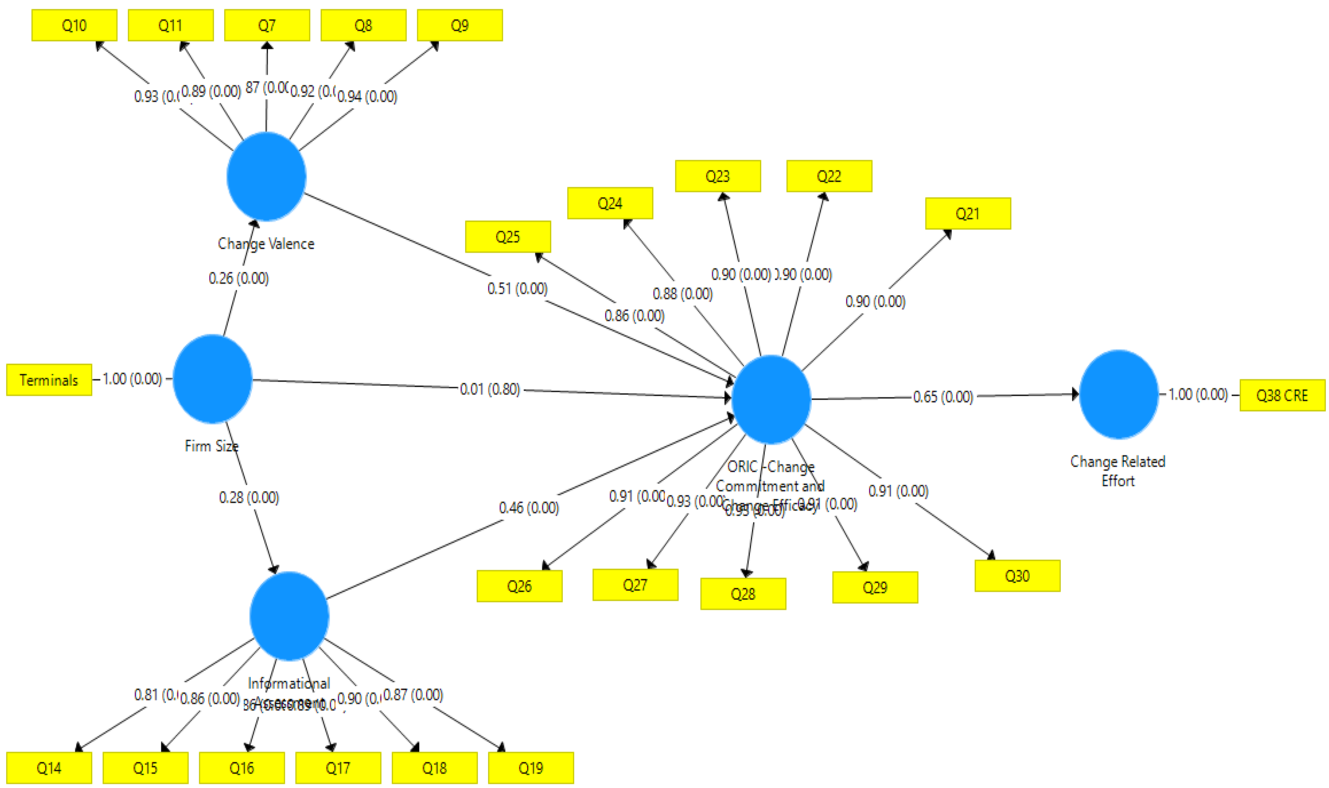

Figure 14: Model by Terminals

Further examination of the organizations also provided interesting insight in relation to the nature of those with change related effort occuring at their firms. When viewed by mode 34 of the 48 (71%) companies were truckload carriers. This is not surprising since truckload makes up the majority of carriers in the industry as a whole. What is interesting however, is the representation of among those who indicated change related effort occurring at their firms along with some of the comments from these firms. It was expected that larger carriers would have more change related effort occurring based on the availability of resources and access to up to date trends and analysis. Larger carriers, those with more than one thousand trucks represented

13% (24 of 178) of the total population of carriers from the study. Of these, only six (3.3%) have any change related effort occurring. Meanwhile firms with between fifty and four hundred and ninety-nine trucks represented 30% (53 of 178) of the overall study participants. Of these twenty one reported change related effort occurring or 45% of those companies who currently have effort occurring come from this population sub-group. This indicates this group may have organizational cultures that embrace emerging technologies or perhaps they are particularly aware of the changes in both their own business or the industry as a whole that is motivating them to embrace the technology.

VII DISCUSSION

VII.1 Key Findings/Limitations

Seventy-three percent of the carriers do not have any change related effort occurring at their firms to address the advent of autonomous vehicles. At the same time 27% do have effort occurring even though the technology is not currently available. Depending on how you view these results, this can been seen as positive or negative for the preparation of the industry for the coming disruption. Regardless of the interpretation of these results, if technologists and policy makers intend to introduce driverless trucks into the trucking industry, they need to be aware of this lack of preparation by the majority of carrier participants. Participants need to understand the organizational readiness of the industry as a whole for the impending disruption driverless trucks will cause. Based on the lack of change related effort occurring with the carriers, either they do not believe the technology is near or they feel it will be unsuccessful in its deployment. Technology providers and policy makers whose mission it is to implement this technology to improve productivity and safety on the roads need to be aware of this lack of activity. The distribution of firm size for the study was skewed towards larger carriers rather than the overall carrier population (i.e. over 90% of carriers have less than 20 trucks (ATA 2015). Our study population only had 45% of the respondents coming from carriers with less than 20 trucks in their fleet. Because the size of our firms were larger than the industry averages it may be concluded these larger organizations will be better prepared than the industry as a whole if the size of the organizations is indicative of change related effort. However, the active involvement of the medium sized carriers (between 50 and 499 trucks) may prove useful when understanding what is driving these initiatives within this group. This may be an example of firms with early adoption tendencies or they may be viewing their place in the eco-system as tenuous given the changes that may come from implementation of driverless technology. Further study of the carriers, especially those in the medium sized range, may prove useful to both practitioners and researchers as technology changes continue to force disruptions.

The study provides empirical support for the Organizational Readiness to Implement Change theory in a setting other than a healthcare setting (Shea et al., 2014), specifically trucking companies. This study found that five of the six hypotheses were in line with expectation of the proposed theory, and that the results were statistically significant. The one hypothesis not supported by the research is consistent with the findings of prior research (Hannon et al., 2017). Hannon proposed there may be several explanations for this discrepancy. One explanation could be that change efficacy is not actually in the causal path leading to change related effort. Change efficacy requires a judgment of the individual based on the capabilities of their organization to implement a change that they may have low confidence in executing given the differing organizational values. Likewise, the adjusted model due to the high correlations among the latent variables demonstrate the respondent may not be able to differentiate between change efficacy and change related effort. When these variables are combined all remaining hypotheses prove to be supported and are statistically significant. In future research modification of the model or the instrument may prove necessary to help explain the path. At this point the research indicates the instrument as constructed should combine not separate change commitment and change efficacy into a combined variable organizational readiness for change. The lack of effort occurring at the majority of firms may help explain some of these results, as the respondents do not see activity occurring to implement this change. Secondly, the evidence of change related effort indicates low levels of current effort and limited empirical examples of it occurring in other organizations. The respondent must make a theoretical assumption on the organizational ability of readiness to implement an unproven or untested technology. Many firms have well established processes and procedures, and this theoretical question may be difficult to be accurately predicted within these organizations. This leap may be too much for the respondent to make until successful implementations at other organizations have occurred and demonstrate the ability to be successful. In setting the boundaries of the study, we focused only on trucking companies, and there may be differing states of readiness within other areas of the transportation eco-system. Safety and technological complexity were two of the most common themes mentioned by respondents when asked to identify the biggest challenge to implementing driverless trucks. This indicates there is a concern on behalf of the respondents to the safety implications of removing the driver from the equation. In addition, there is a technological gap that exists in educating the industry on the capabilities of both the technology providers, as well as the participants, to execute a solution to remove the driver from the process. It is interesting that safety is considered a reason for the need for autonomous vehicles by policy makers and technologists, and safety is one of the largest concerns of those who would be affected by the change. The bridging of the safety expectations, along with the value delivered by creating a safer operating environment, will be critical to gain acceptance by participants. Technology providers and policy makers believe the technology will mean fewer cars on the road, and that should result in fewer traffic accidents. This study was a convenient sample of industry participants willing to respond to the survey.

Eighty percent of the variance in change related effort can be explained by Organizational Readiness for Change (ORC) and the results are statistically significant at $P<.01$, which is demonstrated by the R-squared signifying that ORC is predictive of change related effort. This finding was a predicted result based on the original research conducted by Weiner

2009 in his Organizational Readiness to Implement Change model and is supported from the research.

VII.2 Contributions

This study contributes to our understanding of ORIC as one of the first empirical studies of organizational readiness to implement change in the trucking industry. Since previous applications of ORIC have focused primarily on health care settings, this application provides a framework to assist researchers in additional studies in context areas other than healthcare.
The study has strategic implications for researchers in the study of organizational readiness to implement change for driverless trucks. Those concerned with the problem of the pending implementation of driverless trucks in the commercial trucking industry will benefit from the study as a lens on the current state of readiness of the carriers. Likewise, they benefit from the study as an empirical examination of the research question, What is the organizational readiness for the disruption caused by autonomous commercial vehicles (trucks)?. This is the first study of its type to ask participants in the industry directly about their organizational readiness to implement this autonomous trucks. In addition, practical participants in the trucking eco-system will benefit by providing evidence on the readiness as well as participants concerns to implement the technology currently in development.

The study provides insights for carriers in the commercial trucking industry on its collective organizational readiness for autonomous commercial vehicles. Participants can use this information to make decisions about their own organizations, as well as work with other organizations to prepare for the technology in development. By providing evidence and support for the other eco-system participants goals and objectives, carriers can make better decisions concerning their own organizations and prepare for the changes that will be required. In addition, the study provides support for a process to define where their organizations may be lacking in developing an environment where the readiness of the organization precedes a need for implementation of driverless trucks.

VIII FUTURE RESEARCH

Refining measures and the model to further study organizational readiness and the correspnding variables that determined readiness could prove useful to researchers. Likewise, This study extended the research context from the healthcare setting in which it was first applied to the trucking industry. By extending the research stream to other participants of the trucking eco-system, there could be additional benefit to researchers, as well as practitioners on the readiness of others who will be affected by the implmentation of driverless trucks.

Based on the study findings concerning a lack of statistical significance for change efficacy further testing of the instrument as well as the combined modified model. Additional research utilizing the model and exploring the construct as theorized, or whether there may be a modification required, could prove useful to researchers. By examining the indicators and the respondents interpretations, there may be value in understanding the construct and it’s validity as theorized in the pathway. As part of this analysis futher testing of the instrument could provide useful for theory development. Providing additonal research support for the instrument or modfying it for additional areas of research could allow for additional support for or challenges to existing theory.

IX CONCLUSION

The results of our research question, What is the organizational readiness for the disruption caused by autonomous commercial vehicles (trucks)? indicate there is some activity occurring even though the technology has not been proven. This indicates the carrier industry is aware of and interested in this technology.

It is worth noting the change occurring is not limited to large carriers with extensive resources at their disposal but instead is across the size spectrum and indicates those who are sponsoring change related effort may be indicative of organizations who demonstrate characteristics of early adopters rather than simply the size of the organization.

Likewise, this research indicates further testing of the instrument as well as the model itself needs to be conducted to verify the component parts and help explain the inconsistencies in terms of the relationships of the individual variables. This could be especially beneficial to researchers who seek to better understand organizational readiness for change.

Practitioners as well as researchers could benefit from a concise and reliable tool to measure organizational readiness to implement change. Using a tool to evaluate the readiness for change could provide valuable insight to practitioners as they attempt to deal with the effects of disruptive changes occurring at their firms. Likewise, researchers could use the tool to perform additional change related research to better understand and test theories on organizational readiness for implementing change.

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VITA

Student biography. Interests. Future Plans.