The Future of Global Supply Chain Strategy in a Post-Industry 4.0 Domain

Research Proposal
IPSERA 2018 Doctoral Workshop

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Jessica A. Smith, B.S., M.S.
Center for Operational Analysis (COA)
Air Force Institute of Technology
2950 Hobson Way
Wright-Patterson AFB, OH 45433-7765
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Subject: International Purchasing and Supply Education and Research Association (IPRESA) Statement of Interest _ IPRESA 2018 Doctoral Workshop

Dr Davide Luzzini,

Thank you for the opportunity to present this Statement of Interest to participate in the IPRESA 2018 Doctoral Workshop, Sunday 25 March 2018 in Athens, Greece. Following in the footsteps of my Advisor, Dr Paul Hartman, I am very interested in developing an in-depth understanding of global supply chain complexities and how my doctoral dissertation can be best positioned to add value to this discussion. I recently completed my Master’s degree thesis, *Supply Chain Transformation: An Information Technology Perspective*, and am excited to share my doctoral dissertation research proposal that extends this research with fellow participants and senior faculty members.

As requested, please see summary information below:

Name: Ms Jessica A. Smith  
Affiliation: Air Force Institute of Technology  
Doctoral Student  
U.S. (937) 255-3636 x4672  
Graduate School of Engineering and Management  
Wright-Patterson Air Force Base, Ohio (USA)

Advisor: Paul L. Hartman, Ph.D. (DAF-AD-25)  
Director, Center for Operational Analysis  
U.S. (937) 255-3636 x4521  
paul.hartman@afit.edu

Project Title: *The Future of Global Supply Chain Strategy in a Post-Industry 4.0 Domain*  
Project Description: Scholars have used time-phased segmentation of the global industrial evolution from the 18th Century to present to evaluate intra- and inter-firm dynamics producing significant shifts in the theory and practice of purchasing and supply management (e.g., Coase (1937); Williamson (1979); Barney (1991); and Fine (2000)). Underpinning *The Future of Global Supply Chain Strategy in a Post-Industry 4.0 Domain* is the thesis that firm-level commitment to resourcing strategic supplier and customer relations (e.g., Lambert et al. (1996); Zsidisin and Ellram (2001)) will significantly diminish as markets (e.g., manufacturing, health care, financial services) rapidly adapt and evolve in the post-Industry 4.0 domain.

Thank you for your favorable consideration of my request to attend the 2018 Doctoral Workshop.

Sincerely,

Jessica A. Smith

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Abstract

Throughout history, scholars have used time-phased segmentation of global industrial evolutions beginning in the 18th Century to evaluate intra- and inter-firm dynamics producing significant shifts in the theory and practice of purchasing and supply management. From the first Industrial Revolution to where we sit today in the midst of the Fourth Industrial Revolution, Industry 4.0, each bout of technological innovations has come with its own set of supply chain practices. With the recent importance that has been placed on buyer-supplier relationships and data integration, this research seeks to analyze how information technology has impacted the amount of suppliers a focal company has as well as the type, depth, and cost of each relationship.
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Background

Throughout history, scholars have used time-phased segmentation of global industrial evolutions beginning in the 18th Century to evaluate intra- and inter-firm dynamics producing significant shifts in the theory and practice of purchasing and supply management (e.g., Coase, 1937; Williamson, 1979; Barney, 1991; and Fine; 2000). The first time segment of the American Industrial Revolution movement was seen in the mid-1780s when production facilities began to use water and steam to aid operations (see Figure 1). This Revolution, sometimes referred to as Industry 1.0, lasted eighty-six years. The second American Industrial Revolution, Industry 2.0, occurred in the early 1870s and lasted nearly one hundred years. This Revolution involved the introduction of mass-production techniques (e.g., division of labor and assembly lines) that were fueled by electrical energy.

Within a mere forty-four years, less than half the duration of both Industry 1.0 and Industry 2.0, American companies had experienced the entirety of the Third Industrial Revolution (Industry 3.0). In the late 1960s, manufacturers saw a transition from the use of electronic information technology (IT) systems to more complex technologies of the fourth Industrial Revolution. Today, we sit within Industry 4.0 utilizing cyber-physical system (CPS) technologies, the Internet of Things (IoT), additive manufacturing technologies, and much more. Understanding that the length of the most recent Industrial Revolution dramatically decreased, this research aims to analyze past Revolutions and associated supply chain practices to better understand what supply chain experts should expect to see next.
Interestingly, the new technologies spurring each Industrial Revolution birthed changes in fundamental global supply chain practices and buyer-supplier relationships. Global supply chains date back to ancient times with the trading of spices, silk, and other goods; however, the high transaction costs of long-distance trade at the time limited global supply chain suppliers to restrict products traded to high-value items (Mangan and Lalwani, 2016). In the middle of the 19th century transportation technology saw great advances, with the growth in waterway (e.g. Suez Canal, Panama Canal, etc.), railway, and automobile technologies radically decreasing transportation related transaction costs and increasing opportunities for feasible global supply chains.

With transportation technologies more established and reliable than ever before, 20th century companies became focused on internal supply chain practices. New production methods including the assembly line and mass production techniques were the first wave of business process improvements. Production wasn’t the only aspect of supply chains businesses saw in the 20th century. In the early 1990s, the purchasing function saw a paradigm shift that Clemons et al. coined the “Move to the Middle Theory” (1993).

With relatively stable transportation and production methods, companies sought to reach their next level of competitive advantage by focusing on core competencies and exploiting the benefits of external economies of scale and learning curves through outsourcing and offshoring non-value-added business processes (Clemons et al., 1993). Manufacturers moved to an increase
in the number of suppliers for goods and services historically done in-house due to past technological limitations, with IT allowing for more stable, long-distance buyer-supplier relationships (Corbett, 1996). The shift from rigid, vertically integrated companies to lean corporate strategies that focused on core competencies during this period has been attributed to the “rapid reduction in the cost of IT and reduction in the transaction risk of explicit supplier coordination” (Clemons et al., 1993). This switch to modular structured companies, Tully stated, was critical for companies to remain competitive in the “tumultuous, fast-moving marketplace” (1993).

In the early 2000s, the new trend in supply chains was supply based reduction with the goal of revamping, regaining, and retaining competitive advantages. With computers and internet technologies making production and supply information more readily available, companies began to look internally and externally for cost efficiencies through the systematic elimination, standardization, and tiering of their supply base (Ogden and Carter, 2008). A key aspect of supply base reduction, systematic elimination, involves analyzing and removing all suppliers that you no longer use due to obsolescent or inadequacy in areas like cost, quality, or long lead-times (Goffin et al., 1997). This supply chain tactic led companies to a decrease in the number of suppliers.

**Motivation**

Though information sharing is now considered imperative for supply chain operations, individual entities typically have disparate information systems and databases. Additionally, internal to a single company’s system, data inputs and standards can differ between persons, departments, and locations. A single product may be referred to in a multitude of ways impeding inter-system translatability (Oracle, 2013). Despite the difficulties in buyer-supplier integration,
there has been an increase in technological-enabled methods for companies to communicate and share data with one another.

To see the benefits of accurate information sharing, inter- and intra-firm data, some sort of cleansing, translation, and/or transformation is typically required for the information to be appropriately shared. Understanding this issue, companies and software engineers are now looking for the next data standard to decrease the level of difficulty and increase levels of communicability between information systems. Historically, the integrability of information technology systems and communication interfaces was an important aspect internal to a firm with multiple operations and departments. Multi-location organizations ideally were built on some sort of common base, allowing for each system to operate independently and locally while still being able to communicate with one another (see Figure 2).

Figure 2 (Weill et al., 2002)
Shared Information Technology Infrastructures

The need for data standardization has grown beyond the intra-firm aspect with the growing importance of supply chain integration and buyer-supplier data sharing. Entire industries are now moving toward a single, unified data standard to increase the ease of data sharing and
understandability. The Observational Health Data Sciences and Informatics Organization (OHDSI) describes data standardization as, “the critical process of bringing data into a common format that allows for collaborative research, large-scale analytics, and sharing of sophisticated tools and methodologies” (OHDSI, 2017). The importance of standardization in the healthcare industry was formally acknowledged in 1997 when the Clinical Data Interchange Standards Consortium (CDISC) was created (CDISC, 2017). Technologies such as that of IBM and Oracle allow companies to manually standardize data (IBM, 2014; Oracle, 2013); however, recent scholars such as Kalgren et al. (2017) have established ways to automatically translate data to avoid the tedious manual job of data translation which is often error-prone.

Research Objectives

Rapidly evolving Industry 4.0 technologies paired with increasing amounts of data has had a large impact on the speed and methods of communication companies can share both internally and externally. The increase in cyber-physical systems and decreased cost of technologies poses a multitude of questions which this research aims to investigate. Contrary to what we have seen in the past where buyer-supplier integration has been seen as an important aspect, I hypothesize that the increased ease of communication and data transmissibility will eliminate the need to be fully integrated. The objective of this research is to understand what 2017 Fortune 200 companies have seen and are expecting to see in the type and number of future buyer-supplier relationships considering IT as an influencing factor.

Research Question 1: Is there a negative correlation between information technology and the transactional costs associated with buyer-supplier relationships?

Research Question 2: To what degree should future companies focus on buyer-supplier relationships and information system integration?
Research Question 3: Do companies expect to see an influx in the number of suppliers due to the higher accessibility of supplier data facilitated by information technology?

Methodology

This study will use a mixed methods approach to analyze the three research questions associated with information technology and its impact on buyer-supplier relationships and transactional costs. Mixed methodology uses both qualitative and quantitative analysis techniques to hypothesize and validating or disproving potential conclusions. The use of both methods together allows for an all-encompassing view of the research problem than one alone would be able to provide (Cameron and Molina-Azorin, 2011).

Inclusion criteria of subject firms to be analyzed is as follows:

A. The company must be listed as a 2017 Fortune 200 company.

B. Subject firm must be a U.S. Air Force industry partner or original equipment manufacturer.

Considering these constraints, potential firms consist of Boeing, Caterpillar, General Motors, IBM, John Deere, Johnson Controls, Lockheed Martin, Microsoft, Northrop Grumman and Raytheon. To encourage reliability and repeatability, a previously established, iterative cross-case analysis technique will be performed to analyze overall similarities and differences at the firm-level unit of analysis (see Figure 3). Though there is no documented ideal number of interviewees, four to ten individual cases has been noted to substantiate a reliable qualitative study (Eisenhardt, 1989).

Research Question 1 will be answered through a predictive event simulation using information collected in the pre-interview survey. Potential aspects of this portion of the study include quantitative questions regarding subject firm’s number of suppliers, estimated man-hours dedicated to managing supplier relationships, expenses associated with integration efforts or
information system acquisitions to accommodate supplier related needs, and any other quantifiable costs associated with transactions aimed at maintaining supplier relationships.

Figure 3 (Hartman, 2013)
Research Data Collection and Analysis Approach

The second, qualitative step of this research will include semi-structured interviews with individuals at the executive level (e.g. Chief Executive Officer, Chief Strategy Officer, Chief Data Officer, and Chief Purchasing Officer) of selected companies to answer Research Questions 2 and 3. The goal of the interviews is to obtain insight into what U.S. Air Force industry partners are seeing within their firms regarding information technology and its impact on buyer-supplier relationships and the associated transactional costs. Interviews will be recorded and transcribed, then resulting data will be coded and analyzed.

A cross-case analysis will iteratively be conducted ending in an integrated, detailed case study of selected focal firms identifying streams of significant similarities. Potential interview questions target any subject matter expert observed changes in buyer-supplier relationship dynamics, the level of importance the focal company’s strategy has placed on the relationship. Additionally, follow-up questions will inquire if IT capabilities and access to buyer or supplier
information has been considered a moderator of any observed changes in attitude, strategy, etc. towards buyer-supplier relations.

Implications

The United States Air Force has a multitude of suppliers that comprise its $309 billion supply chain. To support the U.S. Air Force’s mission, there are over 400 information technology systems used globally, most of which are disparate and lack integrated data communication capabilities. With the growth in shareability of information and an increased push for data standardization, I hypothesize leading industry partners are experiencing these changes faster than an entity with a supply chain as large and complex as that of the U.S. Air Force. This research aims to look at lessons-learned to make propositions for how the U.S. Air Force should properly position itself for the future.

Additional follow-on research streams assess how information technology is impacting the supply chain in ways other than the buyer-supplier relationship. Particularly, workforce training and education of new technologies has been a popular topic within the U.S. Air Force (Department of Defense, 2016). Likewise, the new supply chain data analytic capabilities (i.e. predictive and preventative aircraft maintenance and its impact on inventory levels) are potential follow-on topics stemming from IT-enabled supply chain advancements (U.S. Air Force, 2015).
Bibliography


