Social media and supply chain risk management: improving risk detection and supply chain resilience

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ABSTRACT

The introduction of social media has changed the methods by which many individuals, communities, and organizations communicate and interact. The increasing popularity of social media within a business context has forced executives to rethink how they operate their businesses. Chae (2015) observed that the field of supply chain management (SCM) has been lagging in identifying the potential role and use of social media in both research and practice. Recently, greater attention is being given to social media and its potential uses within the supply chain. This paper investigates the potential use for social media as a technology to help with supply chain risk detection and supply chain resilience.

INTRODUCTION

Ever increasing competitive pressures including escalating customer demand expectations, requirements and greater competition from international markets have forced organizations to operate on a global basis (Manuj and Mentzer, 2008).

The increasing complexity of global supply chains necessitates the flow of goods, services, information, and cash, both within and across national boundaries, which must be highly coordinated. With increasing complexity, supply chains have become much more susceptible to disruption (Craighead et al., 2007). The more globalized the firm, the greater the risk exposure due to the increased length of the supply chain network. Numerous recent incidents, including natural disasters, various industrial and societal disputes, and other supply chain "glitches" have revealed the vulnerability of modern global supply chains. Modern supply chains increase the likelihood for potential delay points, providing for greater uncertainty and creating the need for improved coordination and communication. As a result, the modern supply chain must be continuously monitored and managed (Mentzer, 2001) and innovation is critical. Now more than ever, the supply chain and the innovations within are closely linked to some of the newest technologies. Blockchain is the latest technology that in various use cases has the potential to revolutionize supply chains by creating opportunities for improved processes. Innovative supply chain performance improvements demand technology. An additional emerging area of technology which holds much promise for innovative improvement in supply chain management is social media.

Social media is defined as collaborative online applications and technologies that enable participation, connectivity, user-generated content, the sharing of information, and collaboration amongst a community of users (Henderson and Bowley, 2010). The introduction of social media has changed the means by which many individuals, communities, and/or organizations interact and communicate (Kaplan and Haenlein, 2010). In a business context, social media is used in a business-to-consumer (B2C) environment to allow companies to promote their brands and market products to consumers (Howells, 2011). The field of supply chain management has been slow in identifying the potential role and use of social media for research and practice (Chae 2015). However, social media could provide many benefits for supply chain management such as greater visibility, improve communication, increase control, and potentially

reduce operational and labor costs. Social media could allow supply chain participants to monitor supply chain events and transactions to keep everyone up-to-date with current situations, such as a delay in shipping or a carrier failing to pick-up a shipment. Social media may provide companies with more timely and insightful information about risks and events, enabling organizations to take corrective action sooner and thus minimizing the impact of any supply chain disruption and increasing supply chain resilience (Rusch, 2014). It's this potential use for social media that leads to the following research questions:

    (1) Can the use of social media improve an organizations ability to sense and recover from potential disruptions?

    (2) How can supply chain managers use social media to adjust to changes in the upply chain environment?

This paper discusses the use of information technology to achieve supply chain innovation. A discussion of supply chain risk management and supply chain resilience follows. We then we provide background on Dynamic Capabilities (Teece et al., 1997) and describe the connection to the use of social media for improved supply chain resilience. Principles related to disaster recovery and social media are then applied in a supply chain context and propositions are offered. Finally, managerial implications along with conclusions from this examination are discussed.

INFORMATION TECHNOLOGY AND THE SUPPLY CHAIN

Value is created within the supply chain in matching supply and demand through both reliability and responsiveness. Reliability is defined as delivering the right product in the right quantity at the right time to the right place at the lowest cost. Responsiveness is defined as the ability to quickly respond to changing market conditions (Hendricks and Singhal, 2003). To be both reliable and responsive, organizations have formed sophisticated supply networks and management structures that allow materials to be sourced from around the world, while still delivering on reliability and responsiveness (Autry and Moon, 2016). The task of managing those supply networks necessitates coordination both within and across organizational boundaries, including the integration of business processes and functions across the supply chain (Cooper, Lambert, and Pagh, 1997). Some scholars maintain that it is impossible to achieve both reliability and responsiveness, and create an efficient, collaborative supply chain without information technology, noting that; "IT is like a nerve center in supply chain" (Gunasekaran and Ngai, 2004). The business processes associated with supply chain management are deemed mission critical for many organizations (Bala, 2013) and the reliance on IT to help achieve mission critical processes is generally accepted. Some scholars have referred to supply chain management as "a digitally enabled inter-firm process capability" (Rai et al., 2006).

The sharing of information is at the heart of the modern supply chain concept (Thomas, Esper, and Stank, 2010) and the advantages of increased information sharing through greater technology linkages has been discussed in much of the prior supply chain research (Lee and Whang, 2000). Cachon and Fisher (2000) detailed a reduction in supply chain costs with the sharing of both demand and inventory information among supply chain partners. Fawcett et al. (2007), reviewed two facets of information sharing; connectivity and willingness to share, and determined both are not only critical to an information sharing capability but both are found to positively impact operational performance. Zhou and Benton Jr. (2007) explored the effect of information sharing and supply chain practice on supply chain performance. Their conclusions indicated that both are crucial to attaining greater supply chain performance. Klein et al. (2007) found that firms realized better performance when information is shared among supply chain partners. Information sharing improves the coordination of supply chain processes enabling the flow of material and reducing inventory costs, leading to greater collaboration and increased levels of supply chain integration (Li and Lin, 2006).

Supply chains comprise vast numbers of products or commodities that are sourced, manufactured, or stored in multiple locations throughout the world, increasing complexity (Chopra and Sodhi, 2014). Events often occur that threaten to disrupt supply chain operations and jeopardize the ability to perform effectively and efficiently (Melnyk et al., 2015). Natural disasters, political instability, terrorist attacks, equipment failure and human error have all contributed to various supply chain disruptions. Irrespective of the type of disruption, the sharing of information is an essential component within any supply chain to quickly respond to a disruption (Datta, 2017). Supply chain disruptions can be costly and if not properly managed, can result in significant delays and an inability to meet customer demand (Blackhurst et al., 2005). Supply chain managers and practitioners understand the necessity to protect their supply chains from disruptions, unfortunately few take necessary action (Chopra and Sodhi, 2014). The most obvious solutions; increasing capacity, boosting inventory levels and having multiple suppliers, can undermine efforts to improve supply chain cost efficiency and responsiveness to demand changes. Consequently, supply chain risk management has emerged as a top priority for companies (Chopra and Sodhi, 2014).

SUPPLY CHAIN RISK MANAGEMENT AND RESILIENCE

Supply chain risk is defined as the likelihood and impact of unexpected events or conditions that adversely influence any part of a supply chain leading to operational, tactical, or strategic level failures or irregularities (Ho et al., 2015). Supply chain risk management (SCRM), defined as an inter-organizational collaborative endeavour utilizing quantitative and qualitative risk management methodologies to identify, evaluate, mitigate and monitor unexpected macro and micro level events or conditions, which might adversely impact any part of a supply chain (Ho et al., 2015), is rapidly evolving into a preferred area of research for both academicians and practitioners (Rao and Goldsby, 2009). Although scholars understand that SCRM is a necessary part of a holistic supply chain management philosophy, researchers have also

argued that managing risks in the current environment continues to be an increasingly challenging task (Christopher and Lee, 2004). The essence of SCRM is to make decisions to concurrently take advantage of opportunities and minimize risk (Narasimhan, 2009). Scholars have noted that a firm should have a cost-effective risk management strategy for monitoring and detecting supply chain disruptions (Autry and Moon, 2016) and managers can reduce risk by designing supply chains to contain risk rather than allow it to proliferate throughout the entire supply chain (Chopra and Sodhi, 2014). An organization can substantially increase its resilience; that is the ability to resist disruptions and recover operations capability after disruptions occur, by improving its ability to detect and respond quickly to such events (Sheffi, 2105). Despite this, executives have been hesitant to address supply chain risk. There is a perception among executives that providing for risk reduction will lessen any cost efficiencies and other benefits of their existing global supply chains (Chopra and Sodhi, 2014). Trade-off decisions between managing risk and delivering value are important factors for building resilience into the supply chain (Juttner et al., 2003). SCRM is considered to be the principle method for enhancing supply chain resilience (Datta, 2017).

Supply chain resilience is a concept which has received increased attention within the supply chain domain. It is a complex construct, regarded as a dynamic process of directing actions so that organizations always stay out of trouble should a disruptive event occur. The system then initiates a very swift and efficient response to minimize the consequences and maintain or regain a dynamically stable state, which then allows the firm to adapt operations to the new requirements of the changed environment (Datta, 2017). For this research, resilience is defined simply as the ability of the supply chain to both resist disruptions and recover operational capability after disruptions occur (Melnyk et al., 2015). Melnyk et al. (2015) note; "The resilient supply chain requires two critical capacities: the capacity for resistance and the capacity for recovery" (p. 35). Organizations throughout the world have reported incidents of

increased significance regarding supply chain resilience. Datta (2017) detailed the well-known example of Nokia's ability to adapt quickly to disruption by using alternate suppliers following a fire at a key component manufacturer in 2000. The same disruption also affected Ericsson. However, their lack of resilience resulted in a loss of $400 million in revenue. In another example, Melnyk et al. (2015) discussed the ability of General Motors to quickly recover from the Thailand floods of 2011 despite having suppliers in the area affected.

A great deal of the literature concerning supply chain resilience has examined recommendations for structuring a resilient supply chain (Datta, 2017). In his seminal work *The Resilient Enterprise,* Sheffi (2005) illustrates how organizations can decrease the likelihood of a supply disruption by building both redundancy and flexibility into their supply chain. The author notes that using practices such as standardization, modular design, developing collaborative relationships and creating a culture of flexibility can help build a more resilient enterprise. Detailing the importance of managing the efficiency of resilience enhancement interventions, Collicchia et al. (2010) proposed a simulation model specifying the impact of different risk management procedures. Christopher and Peck (2004) specified what they termed the five broad enablers of supply chain resilience. These were supply chain understanding; implying knowledge about supply chain structures, a supply base strategy; selecting the right number of suppliers; supply chain collaboration, agility, and creating a risk management culture. The fundamental principle of supply chain collaboration is that the sharing of information can reduce uncertainty (Martha and Subbakrishna, 2002). The construction of a supply chain that will facilitate the exchange of information between supply chain partners is a key priority for SCRM and improving supply chain resilience (Christopher and Peck, 2004). Autry and Moon (2016) note that a strategy for detection is needed to allocate limited management resources to monitor the supply network to more quickly detect and disseminate information about any disruption. Social media has emerged as a technology and a business tool that can capture and share information, enable collaboration, and improve supply chain

resilience through better SRCM. Thus, social media has the potential to help improve resiliency.

SUPPLY CHAIN RESILIENCE AND DYNAMIC CAPABILITIES

Dynamic capabilities (Teece et al.,1997) was selected to explicate the necessity for the use of social media platforms like Twitter to improve effectiveness and efficiency in supply chain risk management. Dynamic capabilities are defined as 'the ability to integrate, build, and reconfigure internal and external competencies to address rapidly-changing environments' (Teece et al., 1997, p. 516). Dynamic capabilities are considered a response to the need for change, and those changes may take many different forms, including the transformation of organizational processes and the allocation of resources. The changing allocation and utilization of resources is an essential part of dynamic capabilities. These resources can include human capital, including managers and employees, technological capital, knowledge-based capital, and tangible-asset-based capital, among others (Easterby-Smith and Prieto, 2008).

Organizations find themselves resource constrained and are forced to take steps to manage key resources more effectively. In this model, the organization's need to innovate and integrate is critical, even when there is no guarantee of a sustained, competitive advantage (Wade and Hulland, 2004). Technologies, like e-business proved to have a dramatic impact on operational efficiencies. Zhu et al., (2006) examined this area from the technology diffusion perspective. Social media, likewise, is proving to provide both opportunities and challenges in a dynamically changing business environment.

Traditionally, new technologies are introduced into the workplace and accepted and integrated at varying rates, depending upon numerous factors like need and competition (Winter 2003). Social media platforms like Twitter are already pervasive allowing for little to no transition in organizations. In addition, even late adopters and laggards can appear in the marketplace with no apparent long-term effects.

Dynamic Capabilities, originally proposed for information system resources (Wade and Hulland, 2004), is process based and assumes adaptation between an organization's resources and a dynamic business environment. Social media seems to be a natural fit into this sphere due to the almost instantaneous response capabilities and mobile nature of the mobile devices that are common.

SOCIAL MEDIA AND SUPPLY CHAIN RESILIENCE

Social media has gradually become an increasing part of the fabric of society and human social interaction. According to Statista, a provider of market and consumer data, in the first quarter of 2018, Twitter and Facebook, two of the most popular social media platforms, were reported to have 336 million users and over 2.19 billion users respectively (Statista, 2018). With access to such an enormous number of prospective customers, business disciplines such as marketing have made widespread use of social media. The field of supply chain management has been lagging in identifying the potential role and use of social media in both research and practice (Chae, 2015; O'Leary, 2011). However social media has the potential to impact the supply chain in several different ways. This includes increasing productivity, reduced operating costs, gaining marketplace intelligence, better risk detection, improved risk management, and increased resilience.

Fronetics (2014) conducted a survey on the use of social media within logistics and supply chain management. The results indicated Twitter as the first preference social media tool for supply chain improvement. Social media can serve as a tool to facilitate intra- and inter-organizational activities and provide for greater information sharing within the supply chain (Ngai et al., 2015; O'Leary, 2011). According to O'Leary (2011) Twitter messages can be used to provide information about a broad range of supply chain events. Twitter messages can indicate the arrival or departure of a shipment from a specific warehouse, to communicate the need for shipments of a certain type, or to alert drivers to accidents and road closures. According to Rusch

(2014), a few additional examples of the use of social media related to supply chain risk are:

- Information about accidents and road closures can be issued that affect delivery times and can be used to re-route deliveries

- Report weather conditions that might affect shipments

- Facilitate responses to supply chain disruptions via social media

- Share supply chain risk identification to uncover vulnerabilities to mitigate supply chain risks

The case may be made that these examples fall within three general categories as defined by Hines (2016); Customer Engagement, Market Intelligence, and Business Intelligence. Involving customers, almost instantaneously, in the supply chain process mitigates risks of disruption. This might include something as simple as notifications related to local road closures that would delay truck deliveries to communications related to potential weather issues. Mining information across Twitter feeds, capturing that information, and applying analytic software tools increases market intelligence and, when aggregating results with other strategic information sources strengthens overall business intelligence. Used for risk management, an early warning detection system is crucial if risks are to be identified fast enough to do something about them (Burnette et al., 2016).

Examples of some current uses of social media within the supply chain, specifically logistics and transportation, are varied and novel. Smaller trucking companies like Liberty Linehaul Inc. are very involved. Running 75 trucks out of two terminals Ayr, Ontario and the other in Los Angeles, CA Liberty Linehaul operates as a less-than-truckload (LTL) and truckload carrier for a wide variety of customers ranging from Fortune 500 to small local entities. Specializing in what they call the

white glove treatment for products that require a little more care and equipment to ensure safe transit, the company does approximately 27,500 shipments annually. Liberty Linehaul uses both Facebook and Twitter to post about company events, employee recognition, community involvement, safety messages, as well as for driver recruiting (SMPB, 2014).

In addition to using social media to recruit drivers and market their services, some are finding innovative ways to provide for the movement of freight. MercuryGate International Inc. and Con-way Inc. are two such organizations. Both use social media to move freight. In 2010, Con-way Multimodal, a division of Con-way Inc., initiated a service called "TweetLoad." TweetLoad allows carriers to access available loads from Con-Way Multimodal via Twitter. Carriers who follow @ConwayTweetLoad on Twitter can see the latest available shipments as well as links to additional information on the company's link board. Load information is updated on Twitter every 15 minutes, thus allowing carriers who follow @ConwayTweetLoad to have real-time information on available loads. The former president of the American Trucking Associations (ATA), Bill Graves, was quoted as saying, "With this novel use of Twitter, Con-way Multimodal is leading the industry in maximizing the best features of new technology to improve their processes. This is a great example of how innovative transportation companies can make it easier for carriers to do business with them, which will be a benefit to our industry overall." (Fronetics, 2014).

In 2011 MercuryGate International Inc. launched Freight Friend. Freight Friend is a relationship-based load and truck internet posting service for shippers, brokers and carriers. Freight Friend creates a private network between transportation partners and utilizes technology to automatically identify appropriate matches. The combination of the technology utilized, and the relationship-based nature of Freight Friend allows companies to have real-time visibility to book trucks and find freight with companies they trust. According to Mr. Graves, "FreightFriend is perfect for carriers, shippers, brokers, 3PLs and freight management firms who only want to share information with

companies they trust. They can keep their current information in one place, knowing that friends – and only friends – will have constant access. While public load boards fill a real need, they come at a cost – a lot of unknown companies bidding to carry the freight. Private boards are often useful too, but they're inconvenient to carriers with multiple clients asking them to check their bid portals. FreightFriend solves the dilemma with a single service where carriers can easily communicate with all of their clients and brokers can find available capacity from carriers they trust." (Fronetics, 2014).

Alexander (2014) discussed the actual and potential use of social media in emergency, disaster, and crisis situations, noting that just-in-time information can be provided on how to cope with developing situations. He documented how social media may be used in seven different ways within the emergencies field for disaster response, recovery, and risk reduction including; listening, monitoring, integration into planning and crisis management, collaborative development, creating cohesion, furthering causes, and enhancing research. Alexander (2014) further details the need for emergency managers to adapt organizational practices and embrace the use of social media in crisis management. Some supply chain disruptions, by their very nature, can make detection problematic. The concepts of information sharing, collaboration, and integration between organizations could rest at the center of building the continuity and resiliency necessary to detect and manage supply chain disruptions (Autry and Moon, 2016).

LISTENING AND MONITORING

Social media is often referred to as the new "newswire." According to Fronetics (2014), a digital content and marketing firm focused on the supply chain, social media has supplanted traditional news organizations such as the Associated Press and Bloomberg for breaking news. Major events such as the recent earthquake in China, the Boston Marathon bombing, the death of Osama bin Laden, and the engagement of Prince William to Kate Middleton were all stories that broke on the social media website Twitter. Twitter is a micro-blogging

application allowing users to "tweet" a message of up to 280 characters. Because of the nature of its quick bursts of information, Twitter may be particularly useful where supply chain risk detection and disruption recovery is concerned. Quick detection is considered an essential element in the effort to mitigate the impact of most supply chain disruptions (Sheffi, 2015). For example, the United States Geological Survey currently monitors Twitter to detect earthquakes (Sheffi, 2015). "In some cases, it gives us a heads-up that it happened before it can be detected by seismic wave," according to Paul Earle, a seismologist with the US Geological Survey (Sheffi, 2015).

According to Alexander (2014), listening is the sampling of varied output on social media. Whereas listening is passive, monitoring is conducted to improve reactions to better manage an event by learning what people are thinking and doing. Firms have the ability to "listen in" using social media, but they also must be vigilant with rapid and targeted responses (Crawford, 2009). Crawford (2009) noted that the value of organizations listening using social media could be considered in three ways. The first is being seen to participate within a community, the second is utilizing a rapid and lower-cost form of customer support, and the third is gaining global awareness of how a brand is considered and the patterns of both consumer use and satisfaction. For instance, O'Leary (2011) noted that Best Buy uses Twitter to listen, monitor and respond to customer inquiries. Dell employs staff to listen and monitor more than 130 Twitter feeds (Soller, 2009). As supply networks can be extensive and only a limited amount of management resources may be available to commit to the purpose of risk detection, a firm should have a cost-effective strategy for detecting and monitoring disruptions (Autry and Moon, 2016). Listening and monitoring could allow firms to be proactive instead of reactive by providing for quicker reaction and improved response to a disruption. Thus, the following proposition is offered:

> *P1. The use of social media for listening and monitoring is positively linked to improved supply chain resilience.*

The use of social media listening and monitoring for risk management will foster increased communication and significantly help with improved decision making during a disruption. As supply chain professionals are continuously communicating with a broad community of partners and consumers, the use of social media to improve communication may lead to increased information sharing and improved collaboration. In this rapidly changing and competitive environment, the widely accepted use of social media by individuals globally speaks to the application of the Dynamic Capabilities where resources may be used most effectively and with little training.

SOCIAL MEDIA AND COLLABORATIVE DEVELOPMENT

The philosophy of supply chain management is based upon the collaboration of supply chain partners (Stank et al., 2001). Collaboration in a supply chain relates to the capability of firms to work effectively together in both planning and executing supply chain operations toward shared goals (Cao et al., 2010). Higher-level collaboration that brings the resources of diverse supply chain members together in both innovative and distinct ways promises a heightened level of uniqueness and lasting success (Lavie, 2006). The supply chain literature details specific collaboration-driven benefits including faster new product development cycles, shorter delivery lead times, better quality, lower inventory levels, higher productivity, lower materials and manufacturing costs and improved relationship quality among partners (Ferdows, Lewis, and Machuca, 2004; Lee, 2004; Fawcett et al., 2012). Furthermore, effective supply chain collaboration has also been associated with higher levels of customer satisfaction (Frohlich and Westbrook, 2001), differential firm performance (Frohlich and Westbrook, 2001) and the development of new competencies (Nooteboom, 2004). Supply chain collaboration between organizations is a core concept of supply chain management and is considered an important part of current SCRM practices (Scholten et al., 2014; Scholten and Schilder, 2015).

Hammer (1990, 2004) contended that information technology can be employed to dramatically rethink and redesign the core processes responsible for creation of value within the supply chain. An organizations ability to use IT to collect, analyze, and disseminate information need to synchronize decision-making is referred to as supply chain connectivity (Fawcett et al., 2010). When supply chain partners are connected, improved decision-making, along with higher levels of coordination, thus collaboration is possible (Fawcett et al., 2010). Collaboration supports the development of synergies among partners, enables joint planning and fosters the real-time exchange of information (Scholten and Schilder, 2015) necessary for firms to prepare for, respond to and recover from supply chain disruptions while reducing their impact. Pettit et al., (2013) revealed that low collaboration, lack of excess capacity, and minimal flexibility are the major causes of poor supply chain resilience. Wieland and Wallenburg (2012) identified that communicative and cooperative (i.e. collaborative) relationships have a positive effect on resilience.

Information technology is considered an important enabler of supply chain collaboration allowing organizations to share resources and coordinate efforts (Fawcett et al., 2008). Social media is a technology which can allow participants to join forces and connect on a larger scale than most traditional communication methods. This larger network brings greater potential for increased supply chain connectivity and value-added to those who are attached through the network. Given the risks inherent in the global supply chain, especially with sourcing, the use of social media can lead to closer supplier relationships, moving beyond collaboration. The continued need for improved visibility necessitates increasingly closer relationships with key suppliers. Creating a "community" of suppliers, where crucial information, including information about disruptions can be shared in real-time, could provide for increased resilience. Social media platforms such as Twitter, are suitable to be the foundations for such supplier communities. Therefore, we propose the following:

P2. The use of social media for collaborative development is positively linked to improved supply chain resilience.

Collaboration is a precursor to integration. The integration of social media into supply chain management has required firms to better understand the characteristics of integration and the potential effects and impacts for improved supply chain resilience. The motivation for increased collaboration and information sharing is at the heart of the application of the Dynamic Capabilities. Organizations that collaborate will find that their resources, especially their human capital is free to focus on core competencies when using an already familiar technology.

SOCIAL MEDIA INTEGRATION

According to Autry and Moon (2016) a prerequisite for creating and maintaining a resilient supply chain is IT integration. It is considered a chief catalyst for competitive advantage within the context of supply chain management. Moreover, an integrated IT infrastructure is the foundation upon which all modern supply chain activities and processes are built (Autry and Moon, 2016). Access to information from anywhere at any time is critical for effective and timely responses to environmental changes within the supply chain and IT infrastructure integration is considered especially important to ensure that access.

The corporate sector was quick to realize the many advantages of using social media to promote closer relationships with customers, to gain information about products and services, and to enhance public image (Crawford, 2009). Skylar (2009) noted, social media is seen as a relationship tool. Many firms, including companies such as Dell, have used social media to deliver news and provide special offers to customers. However, social media it is now becoming integrated into all business areas. The world's leading enterprise resource planning suite, SAP, currently provides organizations with the capability to integrate with social media platforms. This integration affords social capabilities both

where and when they are required within a firm's business processes while keeping the connection to the working environment. Using SAP Jam, the social collaboration platform from SAP, the social collaboration tools provide structure to social exchanges and work to quickly drive actions, make essential decisions, or to solve crucial business problems (SAP, 2018).

The use of Radio Frequency Identification (RFID) can also be used to generate Twitter messages (O'Leary, 2011). RFID has long been used in logistics and supply chain management to track the movement of products. Alexander (2014) notes an example of a project at the University of Waterloo. RFID-marked cows are robotically milked. Twitter messages summarizing a variety of variables are then generated and sent once the milking process in completed. Based upon RFID events, Twitter can be used to facilitate supply chain transparency and the speed of information flow (O'Leary, 2011).

As previously noted, there is evidence within the literature that integration through information sharing and collaboration provides for improved resilience (Ambulkar et al., 2016; Scholten et al., 2014; Scholten and Schilder, 2015; Harland et al., 2003). Esper et al. (2010) note that an integrated supply chain decision making capability can be paramount when it aids supply chain partners in more effectively managing disruptions. Supply chain integration can be a dynamic capability that assists the firm in overcoming supply chain disruptions in its upstream supply chain (Autry and Moon, 2016). Thus, the following proposition is offered:

> *P3. The integration of social media for supply chain risk management is positively linked to improved supply chain resilience.*

Risk is a variable that can only be mitigated. The nature of risks is that they are often unknown or unforeseen events. The effective and efficient use of resources, such as freely available social media technology to quickly adapt to such events, may provide for improved risk mitigation.

MANAGERIAL IMPLICATIONS

The inclusion and integration of any new technology presents organizational challenges. The introduction of social media applications into supply chains may seem less intrusive due to the general acceptance of its use. However, any new process or procedural change is likely to impact the resiliency of a supply chain. The listening and monitoring capabilities are basically a different form of instant messaging, the differences being the platform and the general acceptance of social media communication. Collaboration is also not a new concept to organizations. Firms have partnered in Electronic Data Interchange [EDI] and Enterprise Resource Planning [ERP] implementations for decades (Iacovou et al., 1995; Young et al., 1999). Collaboration within the supply chain affords involved parties' efficiencies and perhaps potential solutions to ineffective supply chain resilience. It is a certainty that managers must be adept and ready to address the new opportunities, and the new challenges.

While seemingly a minor issue, determining whether to use personal or business devices must be addressed. Most people already carry smart phones with the ability to access social media in its various forms like Twitter® and Facebook®. Should businesses require employees to use their personal devices? Would separate business-only devices be more secure but add additional expense? How should lost or stolen business devices be handled in terms of potential confidential data being exposed? These questions can be addressed by comprehensive policies not unlike those required with the introduction of laptop computers and flash memory drives.

Regardless of built-in safeguards, people remain instrumental in the success or failure of any system. The use of a mobile device and social media introduces potential points of failure as well as opportunities for improvement. While impossible to list all potential failure points, all mobile devices users have experienced issues as simple as a discharged battery. Cellular network outages or lack of coverage may also be a hindrance, and at key

points in communication. The question remains, what additional potential risk areas might occur, especially when dealing with instant communication?

O'Leary (2011) discusses building relationships with customers. These relationships built largely on mutual trust, extend to supply chain partners. Goolsby (2010) discussed the fear of inaccurate information as being one of the critical factors in the success or failure in these relationships. General acceptance by people requires an understanding of what your employees are thinking (O'Leary, 2011). Further, this may include groups formed outside of the purview of the organization allowing workers to criticize management. This may be viewed as spying on employees and data may become scarce or even tainted. Developing bonds of trust with employees is the first step in any successful system. Anonymization of data and perhaps sharing summarized results with employees may be a step in the right direction.

Strategic alignment with any "system" is key to successful implementation and sustainable use. The use of social media for supply chain resiliency will require management to align that use with the strategic mission of the organization. This topic is pervasive across the literature related to information system implementations (Goepp and Avila, 2015; Velcu, 2010; Schniederjans and Cao, 2009). There may be more questions than answers at this point. Does the use of social media offer some new innovative approach to communications across the supply chain, or does it simply replace current forms already in existence? Simply replacing one form of electronic message with another does not address the efficiency or the effectiveness of a supply chain process. This replacement must afford reasonable opportunities for improvement to be justified. The further intrusion of the human element into the process may also introduce data errors or exacerbate efficiency. The introduction of technologies like IoT, or Internet of Things, may mitigate the risk of human error. Because this technology is not reliant upon third-party logistics sources, the inherent higher speeds and accuracy with smart embedded devices may offer solutions to management in relation to integration. As more

devices become capable of listening, monitoring, and collaborating automatically, the integration of IoT solutions is almost a certainty.

Yet another area of technological innovation is the explosion of big data and analytics. Ittmann (2015) concludes with an insistence that supply chain managers embrace the reality of big data analytics and its impacts on identifying value in data. Supply chain analytics is using the data collected from within the supply chain and performing appropriate analysis to provide fast, accurate results to improve decision-making (Ittmann, 2015). Because of the variety of data, the increasing volume of available data, and the requirements for veracity and velocity (Minelli et al., 2013), big data analytics techniques and technology is critical to ensuring that efficiency and effectiveness gains using social media for supply chain resiliency isn't lost. A key factor for the use of big data and analytics is the potential for enhanced visibility of data across the supply chain (Ittmann, 2015; Milliken, 2014, 2015). Milliken illustrates the "transformation of big data into supply chain analytics" from the use of descriptive analytics to the construction of decision modelling.

It is important to remember an important concept first offered by Peter Drucker (1973),

> "Innovation is not a technical term. It is an economic and social term. Its criterion is not science or technology, but a change in the economic or social environment, a change in the behaviour of people as consumers and producers, as citizens, as students or as teachers…" (p.785).

According to Gallouj et al. (2018) the traditional model is for technological change to drive service and social innovation, interestingly enough, the adoption and use of social media technology by individuals is driving the technological innovation in supply chain resiliency applications. As organizations introduce emerging technologies into the strategic flow, it is always important to remember the rationale is not to use the latest software or gadget, the intent must always be to improve the profitability of the business. In this case, improving the channels

of communications, arming managers with instantaneous information, and providing visibility across the supply chain are key criteria in strategic alignment of social media as a tool to enhance supply chain resiliency.

LIMITATIONS AND FUTURE RESEARCH

The potential for the extensibility of any research findings is an exciting attribute of the widespread use of social media in its various forms. Social media is so widely accepted globally, repeating research studies should be possible. Understanding various cultural norms, carefully ensuring model constructs are valid, and other common practices will remain necessary. The limitation of this research is that no real data is collected to assist in determining the validity of our propositions. The need to further study the propositions should be addressed with not only quantitative research, but also qualitative studies to assist in developing themes and additional propositions. As the IoT expands, additional work is needed to understand how to best integrate technology and where human intervention is still required.

Future research could include how is information, leveraged through the collaboration capability social media provides, could be used to increase competitive elements beyond productivity, brand management and customer satisfaction. Additionally, an under-explored area within supply chain management is that of small and medium-sized enterprises (SMEs). Research on the potential use of social media for improved resilience in small and medium enterprises could prove fruitful. Finally, additional case studies related to social media and its use within the supply chain would provide valuable insight.

CONCLUSION

Supply chains are no longer simply a cost of doing business, they have become a platform for growth allowing organizations to reach new markets to touch new customers. To be successful, companies must innovate to compete. Social media has the potential to be an instrumental tool for supply chain managers looking to recognize new innovations, identify new trends and collaborate with stakeholders, and improve relationships with partners and suppliers. Supply chain disruptions are an inevitable occurrence in today's tumultuous business environment (Skipper and Hanna 2009). According to a report in the Financial Times from May 2015, supply risks have more than tripled since 1995. An organization can and should attempt to mitigate potential risks via traditional supply chain risk management practices but cannot prevent all disruptions from occurring.

When it comes to supply chain risk management, having information about what is happening in real time is essential. Whether it is learning about a natural disaster that happened near your manufacturing plant, information that may alter planned travel routes, or observing the path and intensity of an on-coming hurricane; real time information is critical and will enable an organization to make more informed and timely decisions on how to manage or mitigate risk. Alexander (2014) examines the use of social media in the mitigation of disaster risk and improving the management of crisis response. The concepts of a "listening function" and a "monitoring function" (p. 720) are discussed. Social media has the potential to be an invaluable tool for supply chain professionals attempting to collaborate with stakeholders, improve existing processes, increase efficiencies, mitigate risk and promote recovery following a supply chain disruption. The ideas of listening and monitoring, collaborative development, and integration between organizations could be at the core of creating a resilient supply chain (Autry and Moon, 2016). Social media could be an effective tool to add to an organization's risk management toolkit.

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