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Technology in the Supply Chain: How RFID and Software Technologies Impact Organizations' Effective and Efficient Supply Chain Operation.

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Abstract

In an increasingly competitive global market, organizations must find ways to increase effectiveness and efficiency within the supply chain. Through the use of technologies like RFID and supply chain management software, organizations are able to improve processes that directly impact their bottom line. Understanding how these technologies impact successful supply chain operations is more vital now than ever before. Technology is forcing the hand of supply chain managers everywhere and RFID and supply chain management software are two technologies at the forefront of this change.

Introduction

In today's world, technology plays an increasing role in everything we do at home and at work. With these advancements in technology, the world of business is changing, suppliers are easier to reach and manage even from thousands of miles away and this has a significant impact on supply chain. In fact, globalization is forcing many organizations to reconfigure their entire supply chain and reevaluate logistics operations (Zuckerman, 2005). Part of this reorganization revolves around the basic understanding of what effect technology has on supply chain functions and how it can impact an organization's bottom line. RFID and software technologies have been front and center in increasing the efficiency and effectiveness of supply chains all over the world. Organizations must be able to grow with the changes in technology or possibly get left behind by their competitors.

There is no one technological solution for all of the different organizations' supply chain needs. Understanding what is available in terms of RFID and software solutions, what has been tried, what works, and for whom is extremely vital in order to maximize efficiency and effectiveness of the supply chain. Factors such as weak corporate technological culture, technological paradox, lack of technological expertise, under-utilization of technology, and incompatible technological systems continue to affect the implementation of supply chain technology (Adegbie & Adjeniji, 2013). Having a more complete view of the technological evolution within the supply chain can help organizations better understand what to expect when making changes to their supply chain technology as well as knowing what is on the horizon. A better understanding of available RFID and software technology options and future potential will put organizations in an improved position to be more effective and efficient in their supply chain operations and remain competitive in a rapidly changing marketplace.

Supply chain technology is a dynamic capability that firms must build, integrate, and reconfigure to enhance performance (Teece, 2010). Knowing where to start is a more difficult endeavor for many as technology has grown over the past 20 or more years, drastically changing the landscape of supply chain management. It can be difficult for some organizations to catch up with their competitors with so much information available. More and more organizations are looking to the supply chain as a way of gaining a competitive edge and increasing profits. As stated by Dittmann (2010), more firms are realizing that the pathway to shareholder value runs through supply chain excellence. In this effort to improve the supply chain is the need to understand available technology and how it can affect everything from automation to cost reduction. It is crucial to have a resource where organizations can go to and learn about supply chain technology or gain a better understanding of the topic they are only somewhat familiar with.

The purpose of the research presented is to increase the awareness of the changes in RFID and software technology and how they can directly impact supply chain effectiveness and efficiency. Previous articles and research do not provide an overall view for the timeline of technology as well as explore its impact on the supply chain. Although some studies have investigated RFID and software technology applications in specific sectors, this research aims to provide a broader view of the technology history and its current applications in the supply chain. This is needed due to the constant changes in technology and the way business is being done on a global scale. This paper will provide a consolidated resource that compressively examines the RFID and software technology in the supply chain and its role in an organization's ability to operate effectively and efficiently in order to stay competitive in today's global economy.

Literature Review

As technology improves, organizations must look to various solutions in an effort to improve effectiveness and efficiency within the supply chain. Innovations such as RFID and supply chain management software solutions are playing an increasing role. Supply chains are growing longer and more complex and the need to use technology has never been greater. Organizations are constantly looking for ways to progress and gain a competitive edge over their rivals and technology within the supply chain is one way to achieve this goal.

RFID as a Supply Chain Technology

Radio-frequency identification or RFID is one technology that has helped shape the evolution of the supply chain technology and increase efficiency and effectiveness. Some of the initial uses of RFID were in the areas of inventory management and control. Inventory management involves controlling, administering, storing, and using materials and components that a company requires to produce items for sale (Musa & Dabo, 2016). Throughout the process, including replenishment and after production activities, RFID can help an organization keep track of its inventory with greater accuracy than by paper or enterprise resource planning (ERP) solutions alone.

Organizations trying to avoid pitfalls like the bullwhip effect can turn to RFID solutions for assistance. Controlling the bullwhip effect can decrease unnecessary buffer stock and optimize material resources (Wamba and Boeck, 2008). RFID helps control that flow of information providing more accurate, real time inventory data which is key in controlling the bullwhip effect. In addition, the falling cost of RFID technology is making it more affordable for organizations of all types. Although high technology active tags may cost $20-$50 depending on

the use, passive tags used to track things like pallets can cost as little as $0.15 making them an appealing option.

Uses and benefits of RFID as a Supply Chain Technology

A significant amount of literature exists on the use and implementation of RFID and a review of a portion of it will be presented. First, research by White, Johnson, and Wilson (2008) looks at some of the early adopters of RFID technology in Europe and the lessons organizations can learn from their experiences. The authors reviewed survey information from 612 European supply chain managers, focusing on 128 respondents who have begun RFID trials for various reasons and the perceived benefits of the implementation. The model for their study used a cross-sectional survey approach as well as telephone interviews in order to reach respondents. White, et al., (2008) sought to ascertain the impact on RFID trial success of four determining factors: the presence of customer mandates; the organization's industry sector; the self-perceived level of organizational innovativeness; and the level of integration between RFID and the organizations other information systems.

The results of the survey show that the presence of a customer mandate leads organizations to move from a trial phase of RFID use to actual deployment. Given that many retailers have made the use of RFID an "order qualifier" this result is to be expected (White, et al., 2008). The authors also found that logistics and transportation organizations as well as industrial manufacturers expect RFID to reduce costs in various areas. When organizations are not motivated by a customer mandate they most likely relied more on internal factors such as potential cost reductions to warrant the move from trial to deployment. In addition, White, et al. (2008), found that the level of information system integration employed by adopting organizations did not have an effect on the outcomes achieved. It should be noted that perceived

benefits should not be the determining factor in deciding whether an organization should move towards RFID use. It is important to look at all factors including cost and potential business impacts when implementing any technological change and RFID is no different.

RFID technology is being implemented in many different industries and as the technology improves the uses will continue to expand. Revere, Black, and Zalila (2010) review how RFID technology is improving efficiency, enhancing quality, and improving patient safety in healthcare organization in areas including sharing of patient information between departments and equipment tracking throughout the facility. The authors believe that a disconnect exists in what happens when inputs (patients and money) are converted to outputs (outcomes). The patient care supply chain consists of the processes and interactions necessary for an inpatient to receive treatment, realize health improvements, and be discharged (Revere, Black, & Zalila, 2010). Accomplishing these tasks requires a great deal of communication across a variety of people, systems, and processes.

The patient care supply chain starts when patients enter the hospital or healthcare facility. Revere et al., (2010), note that a patient moves through five processes including ancillary care services, pharmaceutical services, direct patient care services, medical equipment or supply services, and work flow services. Within these areas a variety of processes occur and the patient care supply chain needs input from all of these areas before the end of the supply chain can be reached. Despite the vast number of processes within each service area, there exists a significant amount of communication between the processes in each area (Revere, et al., 2010). This is where the use of RFID comes in to play and can provide a great deal of benefit within the healthcare setting.

The authors conclude that RFID has a very high potential for use in a healthcare setting and the ability to reduce costs and increase efficiency in healthcare settings. Communication throughout the organization becomes real time with the use of RFID tags (Revere, et al., 2010). This is an important factor, especially in this setting. Being able to communicate more efficiently and effectively and have everyone on the same page can potentially save lives. RFIDs are enabling healthcare facilities to reduce unnecessary processes by fostering interdepartmental communication, optimizing patient placement and facilitating bed turnover processes (Revere, et al., 2010). In addition, RFID technology is being used to track equipment that is misplaced like wheelchairs and stethoscopes, improve safety by having surgical trays automatically count tools and other surgery related items, and eliminate unnecessary inventory by keeping a more accurate count of things like bandages and pharmaceuticals. Any technology that has the potential to reduce steps, decrease costs, and save lives is worth investigating.

Transitioning to RFID

Often times an organization will be moving from one technology to another as the newer technology evolves and becomes more available. In an article by Schmidt, Thoroe, and Schumann (2013), the authors focus on the migration from barcode use to RFID in a manufacturing logistics setting. RFID has certain advantages over its competitors like barcode technology. RFID does not require a direct line of sight for scanning, is more secure, can carry more data, and is more efficient than barcode technology with the ability to read multiple tags at the same time. Reviewing two RFID case studies, the authors develop an approach for managing an organizations ability to have technologies like barcode and RFID coexist. Migration from barcode to RFID has been identified as one of the principal challenges in the adoption and diffusion of RFID (Chao, Yang, & Jen, 2007). Given this, it is important for organizations not to

dismiss a certain technology just because it may be difficult to change from an existing one. The authors do note that in many scenarios it is likely that RFID will not completely replace barcode technology but rather to compliment it as many organizations, like retailers, will have a need for both.

The first case study within the article looks at RFID implementation at Volkswagen in Germany. In 2008-2009, Volkswagen and two participating suppliers conducted an RFID pilot project at the Wolfsburg plan and nearby facilities (Schmidt, et al., 2013). Over 3000 containers were equipped with tags to support logistics activities via RFID. Everything from forklifts to scanners was equipped with RFID technology to improve material identification and increase process efficiency as it relates to the receipt of goods. The second case study in the article was conducted at SEAT S.A. in their Martorell plant. Like Volkswagen, SEAT S.A. use only barcode at the moment to control inventory but wanted to see how RFID technology could potentially benefit them. SEAT S.A. expects to improve process efficiency and transparency for both material and returnable transport items (RTIs) by implementing RFID technology (Schmidt, et al., 2013). In the first step of the project, SEAT S.A. equipped around 400 RTIs with RFID technology in addition to adding stationary reading points (RFID gates) at entry and exit zones of the warehouse.

The information presented from these two case studies should be examined extensively as they provide a good starting point for an organization that is unsure on how to proceed in when incorporating a new technology with an already existing solution. Co-existence, convergence, and hybridization are likely to play an important role in the transition process and shall thus be considered in RFID-specific implementation frameworks (Schmidt, et al., 2013). Also, understanding limitations of a technology and how that could impact a certain industry was

illustrated in the case studies. It's not enough to just throw money into a technology, RFID or otherwise, and expect improvements or some sort of return on investment. Schmidt, et al., (2013), note that due to implied technological continuity, the emergent technology is likely to profit from established infrastructure and methodology. In addition, as previously mentioned, using a new technology as a hybrid solution can provide a backup that otherwise might not exist if new processes and technology are implemented all at once instead of gradually.

Organizations of all types are getting involved in the evolving world of RFID including some more obvious ones like IBM but also ones that may not be as obvious like AT&T. Fitchard (2005) reported that AT&T conducted a trial that will focus on bringing together all the diverse elements of a fully integrated open-system RFID solution: from procuring the radio tags on the packages and scanners that read them to the network middleware and hardware handling the traffic and ultimately the network connectivity and data centers that will store and pass that information down the supply chain. Although it may seem odd to some for a telecommunications company to get involved with RFID, it shows the reach that RFID technology has and how large organizations that are looking to branch out view it. Fitchard (2005) also notes that medium-sized companies don't have the capital to invest in the infrastructure to manage and store the vast amounts of data a new RFID supply chain would require. This opens up the door for organizations like IBM and AT&T to provide third party services to smaller organizations.

Software as a Supply Chain Technology

Another area that has helped improve efficiency and effectiveness in the supply chain is supply chain management software. In order to stay competitive, as with any other technology, organizations must stay up to date on their supply chain software. An article by Shacklett (2010), notes that the focus in the supply chain software market is on fundamental functions such

as transportation and logistics, product capability and even warehouse upgrades. It is not enough to just buy a software solution and forget about it. Although companies like SAP and Oracle offer supply chain management software solutions, organization can also get customized software. A software solution should fit the organization using it and be constantly reevaluated while seeking improved effectiveness and efficiency in multiple areas across the supply chain as opposed to improving only one or two areas.

Application of Supply Chain technology Software

Buxmann, Ahsen, Diaz, and Wolf (2004), examine the usage and evaluation of supply chain management software in the European automotive industry. In their study, the authors questioned 1000 car manufacturers, suppliers, distributors, and logistic service providers from 25 European countries. The goal was to analyze the organizations objectives as it relates to supply chain management software and then evaluate the degree to which these goals have been achieved. The authors assume that, overall, supply chain management software is introduced to achieve multiple goals across all organizations including reduction of production costs, reduction of lead time, reduction of inventory and shortfall, reduction of transportation costs, reduction of purchase costs, improvement of supplier evaluation and selection, improvement of service levels, and improvement of cooperation.

The study by Buxmann et al. (2004) showed that out of 178 responses, 20.2% of organizations applied a supply chain management software solution, 14% run an implementation project, and 14.6% plan to implement a software solution in the future. Given these numbers, the results showed that in this particular field, 65.8% of the organizations neither use nor plan to implement supply chain management software. The authors questioned the organization who did not implement any supply chain software why they chose not to and 16.2% felt that it was not

necessary for them, 11.1% felt implementation would be too costly and 10.3% indicated that the high cost of the software itself was the main reason for not moving toward a software based solution.

The next section of the study gauges the perceived importance of the previously mentioned objectives of supply chain management software as well as the benefits obtained by the organizations that do use supply chain software. The data by Buxmann et al. (2004) indicated that the most important objective of the 61 responders using supply chain software was a reduction of inventory and shortfall with a response rate of 85.2%. This is compared to only about a 50% who felt that reducing transportation costs was an important or very important objective. The least important objective identified was to improve cooperation with only 27.8% of the organizations rating it as important or very important. This is a surprising number given that Schmitz Whipple and Gentry (2000), noted that companies are dependent upon each other as they are all part of the supply chain and may actually achieve competitive advantages through cooperation.

Finally, the study by Buxmann et al. (2004) looks at 36 organizations that provided responses to the benefits of using a supply chain management software solution. The highest benefit was for the respondents showed that 14.3% of organizations obtained reductions in their inventory and shortfall. It should be noted that this was also the highest rated objective so there may be a connection between objectives and benefits. In addition 13.7% saw a reduction in lead time, an 8.8% average reduction in transportation costs, and a 9.4% reduction in production costs. Despite the small number of companies that provided information on this subject, the results indicate that the use of supply chain management software can help companies achieve cost and time reductions as well as service improvements (Buxmann et al., 2004).

Although the previous study only focused on the auto industry in Europe, supply chain software can be used in all types of organizations. An article by Friend and Thompson (2002) looks at the use of supply chain software in the food industry. Each industry has its own unique difficulties as it relates to the supply chain and this is true for the food industry as well. The variation in raw product combined with the proliferation of SKU's creates significant challenges for supply chain software vendors (Friend & Thompson, 2002). The authors also note that the spectrum of business processes involved as well as cooperative development of suppliers through ingredient procurement makes it difficult to develop an all-inclusive supply chain software solution that fits the needs of the food industry.

Friend and Thompson (2002), list 3 main elements of the food supply chain that must be taken into commiseration for supply chain management software solutions. These elements are the forecast/prediction of the sell side demand for products from the consumer to the agricultural source, the specification of products and ingredients and packaging components from suppliers, and finally, inventory visibility. The three previously mentioned elements must be considered when looking at the various components of supply chain management software like demand management, production planning, supply chain event management, supplier relationship management, and product lifecycle management, just to name a few. This is where customized solutions can play an important role. Some of these functions may be more important in one industry than another.

In an effort to find a solution that fits the specific needs of the food industry, some organizations are turning to solutions from within. One example listed by Friend and Thompson (2002), is the California Tomato Growers Association along with members of its supply chain are using eTomato web based software developed by John Deere's Agris unit to capture crop

characteristics and field chemical application history as the product moves from the fields to tomato processing facilities. One processor was able to reduce outbound transportation costs by 2% by switching to a customized software solution. Friend and Thompson (2002), conclude that in order for food safety to be ensured throughout the supply chain, software will have to be more responsive and give real time information from the field to the customer.

Benefits of Supply Chain Technology Software

Organizations may know that it is time to implement or upgrade a software solution but cost is always a consideration even when evidence shows that savings can be achieved in the long run. As confirmed by Shacklett (2010), many organizations find themselves in positions where they must update supply chain software that is out of date or at the end of its life cycle. An example of this as presented by Bond (2014), is Lennox International, a manufacturer of HVAC systems who recently adopted a new software solution and saw a 50% increase in productivity, a 1.7% increase in shipping accuracy, and a 2% increase in inventory accuracy. The vice president of supply chain logistics at Lennox International note that the new software helps dissolve operational silos while promoting strategic decision making. Although the improvements may seem small they can add up over the long run and be what determines success or failure in a competitive market.

Also, selecting the right software can be a challenge. Shacklett (2010) notes that that one of the most monumental shifts is a move away from traditional corporate thinking that a high degree of software customization to the business produces a competitive advantage and that packaged software can do an adequate job for the supply chain as long as it includes industry wide best practices. This goes against some of the findings by Friend and Thompson (2002) that customized solution may work better but it does show that each organization should investigate

what would work best for them based on all factors involved. An article by Fowler (2013), provides some key points on how to select the right software solution for your organization that include calculating potential return on investment, considering all IT options, carefully reviewing the costs of a new system, and thinking long-term as it relates to your supply chain and the software solution being investigated. Using the key points Fowler noted can help guide an organization to ensure that they are selecting the right supply chain software solution.

Regardless of the type of technology an organization is looking to implement from RFID to the various software solutions, research shows that when used correctly, efficiency and effectiveness can be improved. In a world of growing supply chains that seem to get longer and longer, having the right technology in place is becoming more important. Technology in all areas of the supply chain will continue to evolve and organizations must stay ahead of the curve. Although things like RFID and new software solutions may not be easy tom implement, the results similar to the ones seen by White, et al., (2008), Revere et al., (2010), Schmidt, et al., (2013), Buxmann et al. (2004), Friend and Thompson (2002), and Bond (2014), among others, across organizations of all types are difficult to dispute.

Discussion

The technology we use has evolved over the years and continues to change at a rapid pace. What started as small implementations of technology in the form of things like calculators has expanded into what we see today with computers, specialized software for various applications, smart phones, and the list goes on and on. This trend in increasing technology use holds true in the world of supply chain management as well. For most organizations, the days of filling out paper forms and manual inventory tracking are over and replaced with scanners and

electronic databases. Understanding where this technology has come from and what it means to organizations is becoming more and more important.

The amount an organization can invest into supply chain technology depends on its available resources and each organization is different. That is to say there may not be a one size fits all solution but having an overall understanding of how much to potentially allocate to various technologies yielding the most benefits is key. Research by Gartner Inc., noted that spending in the worldwide supply chain management software market totaled $7.7 billion in 2011, a 12.3% increase from 2010 (Fowler, 2013). This number shows the importance of understanding where this money is going and ensuring that the investment is made in the right technology for the organization in question. One key in successful technology adoption is to know what you are looking to gain from the technology and the results you expect from the technology prior to approaching a potential vendor (Shacklett, 2010). In addition, things increasing supply chain length and complexity make it even more important for organizations to have technology based solutions for their supply chain.

Part of this technology revolution is the use of RFID and supply chain management software to improve efficiency and effectiveness in the supply chain. The use of RFID has been pivotal in the improvement and optimization of supply chains everywhere in various business types from retail and manufacturing to shipping and packaging operations. RFID technology consists of tags and readers. The RFID tags can be passive or active and contain an antenna and memory. The readers are the device that interprets the information contained on the tag for the user. Another part of the RFID system is what is known as middleware which acts as a connection between the RFID hardware and the organizations software. The middleware gathers

and processes the RFID information from the tags that is read by the transceivers and removes any incomplete information or tag information that has been read multiple times.

Depending on the size of the organization in question and the technology being implemented, there will always be costs associated with the transition to the new way or method and RFID is no different. The benefits of RFID technology are apparent but that does not mean that they come without challenges or recurring costs. An organization cannot simply wake up one day and implement an RFID solution without any planning or processes overhaul. Using techniques like business process reengineering, organizations can successfully implement RFID solutions and get the most out of it. Business process reengineering emphasizes an all inclusive focus on business objectives and how the processes relate to those objectives while encouraging a full transformation of the processes involved rather than an iterative optimization of sub-processes (Musa & Dabo, 2016).

RFID can help contain the increased amount of information that is involved as a result of globalization and supply chains that seem to be getting longer and longer each year. With the constant search for the lowest production and labor costs, the supply chain will continue to stretch and become more complex. Issues like inventory inaccuracy can have a drastic and negative impact on the bottom line of an organization in competitive markets. Inventory inaccuracy is any discrepancy between organizations actual on hand inventory and the recorded levels of inventory in the system. Everything from shrinkage and misplaced inventory to transaction errors can contribute to inventory inaccuracy and RFID can help. This is no small problem either, as an investigation by DeHoratius and Raman (2008), of 370,00 inventory records from 37 stores showed that 65% of those inventory records were inaccurate and that these inaccuracies could reduce profit by 10% or higher. Some high level managers and CEO's

that are resistant to investing in RFID might change their opinion if they knew it was affecting their bottom line by 10% or more.

Another key area where RFID helps facilitate smooth and efficient supply chain operations is in logistics and physical distribution management. Recently, RFID technology has also been used to improve order tracking and location as well as shipment tracking in real-time. Having the ability to track the distribution progress of products can be beneficial for organizations that practice just-in-time (JIT) inventory strategies. It's not just through the supply chain where RFID can assist in physical distribution tracking and management but in the organizations facilities as well. Organizations like Amazon can use RFID tracking to follow a product through their expansive warehouse facilities where products could otherwise easily get lost or misplaced. Also, organizations are using RFID-enabled item-level retail systems to facilitate information exchanges between multiple retail channels (Yoon & Zhou, 2011). Knowing where your product is and when you are going to receive it is instrumental in maintaining normal flow of goods.

The proper implementation and use of RFID technology can increase process optimization and improvement as well. Under process optimization and improvement, research has advanced along three main axes, namely improving material and information streams, perfecting information capture and sharing, and expanding and enhancing the effectiveness and efficiency of business processes (Musa & Dabo, 2016). With RF readers having the ability to read in the area of 200 RFID tags in a single second with no line-of-sight requirement it is easy to see how existing processes can be improved through its use. Automation is becoming a bigger topic with organizations each year and RFID has a spot in the automation world. When

combined with other technologies like temperature and pressure sensors, RFID can expand its role in an organization to fit a variety of needs through an assortment of industries.

RFID, like many technologies, is not without its issues. One problem noted in the literature is that many of the RFID systems are closed. An example of this is an automaker that uses RFID technology to track inventory between plants but the system is closed off to other outside suppliers and business partners. The concern for security obviously plays a role in this but in order for RFID technology to be used to its fullest extent; it must be used between all parties of the supply chain. Also, low-cost RFID tags are generally susceptible to reverse engineering and a captured tag can also be cloned and attached to many counterfeit items (Arbit, Oren, & Wool, 2014). Most organizations are or should be worried about the security of their supply chain and RFID is no exception.

There is much research that still needs to be done as it relates to RFID and the supply chain including the cost of implementation. Also areas of RFID's impact on reverse logistics should be explored in relation to how it can increase visibility for the supplier and customer. With organizations struggling to compete with one another, a well formulated decision based on all available evidence should be made when deciding on RFID implementation. Organizations and researchers must look at and measure the benefits of RFID and compare that to the cost of adopting and implementing the technology. Certainly, the benefits of RFID will be based on many factors including the size of the organization, type of business, and the culture of the organization just to name a few so it is important to understand where your organization stands as well as where it wants to go when deciding if RFID is the right fit.

Supply chain software technology is another area where organizations can improve effectiveness and efficiency within the supply chain when it is implemented and used correctly.

Software of some kind is used in most of the technology we interact with on a daily basis. Any device like a cell phone, computer, even many modern cars have some variation of software that runs the hardware or helps maintain the system it is running on. So it should be no surprise that supply chains of all sizes are using or are looking into incorporating supply chain software technology. As with other technologies, supply chain software technology has changed and improved over the years making it more available to organizations looking to bring their supply chain operations up to date.

The term, "supply chain management software," is used to describe a variety of software tools used to initiate and complete different types of supply chain operations and processes within the supply chain itself. Supply chain management software can be implemented to perform many functions including processing customer requirements, warehouse management, inventory management, purchase order processing and supplier relationship management just to name a few. Similar to RFID technology, supply chain management software can help connect all pieces of the supply chain and open lines of communication between business partners. Software can help quickly process transactions that were previously done manually as well as notify a supplier when inventory is low and needs to be replenished. For example, using software like SAP can not only help track invoices but it can also automatically trigger a reorder of a part when inventory is low. As mentioned before, each organization is different and their supply chain software will be based on their needs.

Although there are many stand-alone options available for organizations that address one or two parts of the supply chain, many supply chain software providers are moving away from the stand-alone applications and moving towards complete systems. Software providers like SAP provide users with an end-to-end solution that encompasses all areas of the supply chain

from transportation management to supply chain even management. This enterprise level supply chain software solution gives an operation the tools to create and test effective business strategies and plan ahead by incorporating commands necessary for preemptive strikes (Rogers, 2011). In a competitive marketplace, knowing when to reorder raw materials, or having improved communication with suppliers can have a significant impact on an organization.

Supply chain management enterprise solutions software can be split into two essential groups, applications and solutions. The application software has the ability to arrange and control various supply chain processes across the entire organization. The solutions portion of the software is responsible for executing the plans and processes that were formed by the application side of the software. It is this complete solution that many large organizations with complex supply chains have turned to. It may be easy for a one person business to track orders, communicate with suppliers, and handle shipping but it is much more difficult for multinational organizations and these supply chain software solutions like SAP and Oracle that are leading the way to improve effectiveness and efficiency within the supply chain.

The internet has played a role in the evolution of supply chain management software as well. There has been an increase in the use of internet based supply chain management software in the form of web-based solutions. These web based software solutions provide an on demand option for organizations of all sizes. Also called, "computing in the cloud," this format enables clients to use software solutions without having to own, repair, upgrade and maintain their own IT systems and equipment (Rogers, 2011). This can provide an enticing option for organizations that are hesitant to invest too much or just don't have the resources to expand an already existing IT depart to include new supply chain management software. In addition, it allows those

organizations with limited resources the ability to obtain the software solutions a-la-carte as opposed to being forced into buying a complete enterprise solution.

One of the things that many organizations are looking for as it relates to supply chain management software is flexibility and ease of use. Having a software solution that is too difficult for employees to use or that can't change with the times is a waste of time and money. The best way to handle large quantities of information quickly is by building in the necessary flexibility and having information flow through hubs, and by creating adapters that link to other software systems such as those from SAP or i2 (Stone, 1999). With that being said, similar to other technologies, organizations must consider how difficult integration of the supply chain management software will be. Just investing in specific software is usually not enough, there has to be a merger with other methods or technologies that are currently being used. Certainly there may be some scenarios where an organization is starting from scratch and will simply purchase the software that is needs but for most that won't be the case and this new software must coexist with other software.

If the current hardware or software is unable to accommodate the requirements of the selected supply chain software it can pose problems from implementation and integration. Not getting the most out of any technology is like leaving money on the table. Also, investing in software that isn't optimizing processes can deter decision makers from investing in the future. It is extremely important that all avenues are investigated when selecting a software technology, particularly when it is being integrated into an existing one so that the maximum results can be achieved. Organizations must understand their needs and their capabilities when selecting and attempting to implement or integrate supply chain management software by having a complete understanding of what software is available and what the pro's and con's of each are.

The cost of supply chain management will vary depending on the size and needs of the organization. As mentioned, there is a wide variety of options available from online need based solutions to complete end to end solutions and the cost will fluctuate depending on the choice. For example, SAP typically costs $1400 per user for their starter package which may not include everything that an organization needs. This is not surprising considering that the supply chain management market is on track to reach $16.3 billion in sales by 2020 – an increase of about 9.5% annually over the next four years (McCrea, 2016). Much of this will be a result of organizations updating old systems, improving software functionality, and moving to cloud-based systems.

Supply chain management software has its own set of issues and challenges as well. As previously mentioned, implementation and integration can be challenging for many organizations and may keep some from wanting to invest. In addition, there is such a wide variety of options to choose from, it may be overwhelming for smaller organizations to select what is best in terms of online vs. in-house or a-la-carte vs. tailor made. Also, with the rise in cloud-based or online software solutions the risk of a cyber attack or hacking increases, potentially putting sensitive information in the wrong hands. It is important for organizations to balance these risks and challenges with the benefits of using any type of supply chain management software while taking into consideration things like master data integrity which should be of the highest significance for all organizations.

Conclusion

The business landscape of today is drastically different than it was 50 years ago. Globalization is the catalyst that is forcing change in organizations all around the world and supply chain management is front and center. Organizations have more suppliers, more needs,

and more competition than ever before. The result of this changing landscape is an extremely long and complex supply chain that is becoming more and more difficult to manage. It's not uncommon to have multiple suppliers and customers thousands of miles away or in various countries around the world. Knowing how to manage this growing supply chain effectively and efficiently can be the difference between success and failure.

The role of technology in all of this change is an important one. It is easy to see changes in our everyday lives in terms of new computers or cell phones but changes in business technology are not always as easily noticed. In order for organizations to remain competitive they must keep up with changing technology, particularly in the area of supply chain management. This may be easier for large organizations that have dedicated technology professionals on staff but not all organizations have the same resources. In addition, not all of their supply chain management technology needs will be the same either. Understanding what is available and how it can impact effective and efficient supply chain operations is vital.

RFID and supply chain management software are two technologies that have helped organizations of all sizes reconfigure their supply chains. Over the years, these two technologies have become more cost efficient and effective than ever before. Organizations of all sizes can now have access to RFID and supply chain management software that may have previously only been available to Fortune 500 companies or other large companies with more financial flexibility. With so much emphasis being placed on the bottom line and being lean, these two technologies can help organizations achieve effective and efficient supply chain operations when implemented correctly. Of course, some organizations may benefit more than others depending on their specific needs but using technology vs. doing things by hand has the potential to provide some benefit to all in one form or another.

RFID and supply chain management software can help with improved inventory control, order processing, shipment tracking, and supplier communication just to name a few. As the technology improves, so does their use within the supply chain. The literature of Schmidt, et al., (2013), Revere et al., (2010), Bond (2014), Buxmann et al. (2004), White, et al., (2008), and Friend and Thompson (2002), and others supports the fact the correct use and implementation of these technologies can play a role in improving effectiveness and efficiency in the supply chain. As previously stated, there is no one size fits all technology solution for any organization so it is important to understand how these technologies function and what the potential benefits and drawback can be when using them. One thing is certain, technology will continue to evolve and the way we use technology in the supply chain will continue to improve.

Future Research

Although the information presented here provides a good foundation a significant amount of research in the area of supply chain technology still needs to be done. In particular, in the area of how technologies like RFID and supply chain management software work together in the same setting. Also, more research should be conducted on expanding the application of RFID and supply chain technology software. In addition, research needs to be done in the areas of technology use in organizations of varying sizes. Research on RFID and supply chain management software technology advancements and improvements should be considered as well. It is always beneficial to know and understand the changes in a particular technology as they are happening as opposed to after they have already been implemented in the market.

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