Integrated Supply Chain Technology in Enterprise Environments

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Abstract

Integration of the supply chain may be one of the most important evolutions of modern enterprises. Integrated supply chain management systems make the flow of data and goods more streamlined and efficient. Research shows that the benefits of a properly integrated supply chain can increase efficiency and provide an advantage over competitors. A study of Neway, a Chinese valve manufacturer, shows that an integrated supply chain can provide a high return-on-investment, as well as improved customer satisfaction and more accurate inventory control. Several challenges, such as poor information availability and complex interfaces, make integration difficult. Technologies like autonomous agents, electronic data interchange (EDI), service-oriented architecture (SOA), and application programming interfaces (APIs) are currently making integration possible. Future technologies like cloud-based solutions and blockchain appear to be promising for increasing the advantages of integrated supply chains.

Integrated Supply Chains in Enterprise Environments

Supply chain integration may be one of the most important methods for organizations to gain an advantage and improve efficiency for their operations. According to Misra, Khan, and Singh (2010, p. 102), "The supply chain encompasses all activities associated with the flow and transformation of goods from the raw materials stage, through to the end user, as well as the associated information flows." When the processes and entities involved in the supply chain are not integrated, the flow of data and goods can be inefficient and uncoordinated. An integrated supply chain management (SCM) system streamlines these processes and flows of materials and data to ensure the "right product or service is delivered at the right quantities, at the right time, to the right places" (Xu, 2011, p. 183). The objective for this cooperation among all entities involved in the supply chain is to be more efficient, which creates an advantage over competitors. This advantage might be the difference in winning and losing in a market.

To take advantage of the cooperation efficiently, better integrated systems are needed that allow partners to collaborate in real time. In order to accomplish this, supply chain management systems need to be smarter, allowing for automated processes where possible and providing better information flow for faster results. The system must also be flexible and adaptable to meet changes within the supply chain. It must also be able to communicate with various legacy enterprise systems (ESs) that may be in use by one or more of the participants. With the right SCM system integrating the information flowing through the supply chain, better quality control can be achieved, as well as better customer service and more accurate forecasting.

Why are SCMs important for today's enterprises?

While ESs and enterprise resource planning (ERP) systems are comprehensive in integrating business applications and resources within the organization, they "generally do not gather real-time information from everywhere in the supply chain" and "often contain static, dated information only related to subsections of the supply chain," (Misra *et al*, 2010, p. 104). To solve this, supply chain management systems were developed that can forecast demand and operate among multiple organizations to provide the proper data flow among all participants in the supply chain. According to XU (2011, p. 183):

> With the implementation of SCM, suppliers and customers are viewed as partners and their relationship becomes a cooperative one as enterprises in the supply chain recognize that coordination among partners within the supply chain is a key factor of success. In order to operate a supply chain efficiently in a cooperative manner, all related functions across the supply chain must operate in an integrated manner in which the various partners within the supply chain must be efficient with respect to every aspect including quality management.

The positive effects of SCM are numerous, including increased production, better accuracy in shipping and inventory control, reduced inventory, and more accurate forecasting (Misra *et al*, 2010, p. 103). While enterprise systems may seem to include the necessary subsystems and data to cover supply chain management, they are not designed to use this information in a manner that makes real-time decisions and results possible. Supply chain management requires this real-time data sharing and decision making to function efficiently. The SCM system is less comprehensive in the enterprise data but collects and integrates the data needed to make correct decisions at all stages and from all participants of the supply chain at any time.

A Case Study of SCM Integration

A study of integrating the supply chain management system with an enterprise system was conducted on Chinese valve manufacturer Neway by Pose, Pal, and Ye (2008). In the case, Neway was undertaking a large-scale implementation of a new e-SCM system that needed to integrate with the current ERP system and database. The current ERP system worked well but had limitations that included lack of planning execution, reliance on manual collection and input of data, and poor coordination with customers and vendors. They chose to use an e-SCM solution from Wmsvision to address these issues.

The e-SCM system could obtain up-to-date information from the ERP system and provide data back to the ERP system. It could send tasks to workers using hand-held devices via wireless LANs and receive feedback from these devices. This real-time transfer of information from system to worker and vice-versa reduced or eliminated paperwork. The system managed receiving of materials and placement in the warehouse, complete with inspection and barcode labels.

The system was designed to provide inventory management and communicate that to the ERP system for adjustments. It also updated inventory during shipping and receiving operations and tasked workers to put up or pick orders via the hand-held devices. The system communicated with the ERP system and outside vendors and customers using XML (Extensible Markup Language), a language that has been widely used and standardized, for easy integration.

Some hardware modifications were required, such as new hand-held devices with larger screens, installation of new servers, desktop computers, and network devices, and an upgrade to the leased line from 2 Mbps to 100 Mbps to handle the increased need for bandwidth. The total

initial budget for the project was almost US $92,000. However, there were several benefits of this integration and addition of the e-SCM system to counter the cost, as outlined in Table 1 (Table 3 in the referenced article, p. 239) below.

They reduced lost sales by about US $20,000 per year and saved around US $1 million per year due to the increased operational efficiency, giving the project a high return on investment. This case shows how valuable a properly integrated SCM system can be when used to compliment the ERP system and streamline the supply chain.

Present SCM technologies

Difficulties involved with integrating supply chain management include poor information availability and complex system interfaces functioning between organizations. These interfaces can be costly, as well. Many of these problems are being overcome using the internet and new technologies that operate via the web.

Agents are autonomous systems that perform a process or service in a specific environment without human input (Shen and Norrie, 1999, p. 4). Agents perform functions and communicate with each other in an integrated enterprise environment using network connections. To do this, computer systems and their functions can be encapsulated using an agent software for incorporation into the larger enterprise and supply chain integrated system, or new systems that perform specific functions may be introduced as agents. They may be systems at retailers, distribution centers, plants, and suppliers that work together in the supply chain. There are many different designs for agent-based systems in enterprises that are driven by different goals or objectives for the systems. The design also depends on the function and level of autonomy and intelligence of the agents.

There are several advantages to agent-based systems that apply to enterprise and supply chain systems (Shen and Norrie, 1999, p. 12), like:

- increasing the responsiveness of the enterprise to the market requirements;
- involving customers in total supply chain optimization;
- realizing supply chain optimization through effective resource allocation;
- achieving dynamic optimization of materials and inventory management;
- realizing total supply chain optimization including all linked enterprises;
- increasing the effectiveness of the information exchange and feedback.

Another method being used is electronic data interchange (EDI). EDI is a standardized method of data exchange between systems. There are several standards available, so businesses that need to exchange data using EDI must agree on the standard and version to be used. EDI translators are available to allow internal systems to use the EDI data ("What is EDI (Electronic Data Interchange)?", n.d.). The main drawback with EDI is the inability to track the status of an order or shipment in real time. The process of exchanging data and converting it to formats that can be used by different systems takes time that may not be acceptable.

Another important technology is service-oriented architecture (SOA), which uses web-based applications and services to integrate the supply chain. Tom Dwyer (n.d.), editorial director and faculty member of BPMInstitute.org, explains, “SOA can unify the underlying data silos and business processes across multiple applications with a combination of application middleware and portal technologies that call on web services to dramatically improve operations and create streamlined interactions.” SOA works by providing services that can be called by applications using standard web languages like SOAP (Simple Object Access Protocol) or HTTP (Hypertext Transfer Protocol). The services are advertised using the Universal Description,

Discovery and Integration protocol (UDDI) and described on the registry with WSDL. Communication between applications and servers is usually done via XML. The standardization of these languages and protocols makes SOA a method that allows suppliers, manufacturers, distributors, and customers to access the data and information in real time across organizational boundaries.

The technology that allows SOA and many other web-based applications to communicate is application programming interfaces (APIs). These interfaces are the links that allow information to travel between applications and systems as it moves through the supply chain via the internet. "APIs (Application Programming Interfaces) enable communications between different apps. Together with the connections between them they've been described as 'the plumbing of the Internet of Things', as well as the EDI of the 21st century," (Braun, n.d., p. 7). Using APIs and SOA allow a SCM system to track an order and update its status in real-time. This is important for many supply chains seeking to become more efficient and agile to gain the advantage in today's fast-paced markets.

The Future of SCM

As technology evolves, new methods appear in the digital supply chain world. One of those methods is Software-as-a-Service (SaaS). The popularity of SaaS is growing at a fast pace and Braun cites Oracle's CEO as saying that it will be in widespread use by 2025. Also referred to as Cloud-based software, SaaS is not a new technology. However, increased access and exposure to the web by suppliers, manufacturers, and customers is making it more appealing as an alternative to EDI and API based systems. It also reduces IT costs "as you can refocus personnel to other areas when you outsource to a SaaS provider," (Braun, n.d., p. 4). The cost

savings apply especially to small and medium size organizations, as larger enterprises may already have the IT resources available to make using licensed on-site solutions more feasible and cost effective in the long term.

That doesn't mean that large enterprises are not being lured to SaaS solutions, or at least hybrid solutions that combine parts of both on-premise and SaaS to best meet their needs. In an industry article from Accenture ("Supply Chain Management in the Cloud", 2014) it is explained that connectivity among all participants in the supply chain leads to better information flow, which increases real-time visibility, promotes collaboration, and improves customer satisfaction. The connected network improves the intelligence of the system allowing for better data to support improved decision making, efficiency, and innovation. Finally, a connected, intelligent network makes scalability more feasible. This flexible model has the ability to react to volatility, again increasing efficiency and customer satisfaction. It is also better able to adjust rapidly and reliably. The article also lists speed of deployment, single source of truth, low cost-of-entry, and increased business value as benefits to SaaS solutions.

Another factor that is likely to play a large role in the future of Supply Chain Management and integration with ERP systems is Blockchain. Blockchain is a form of electronic ledger that chains together block hashes of transactions. Victoria L. Lemieux (2017) explains:

> Each blockchain has a consensus mechanism that ensures that updates are agreed to and communicated transparently across the entire network, so the order in which transaction records enter the blockchain is undisputed, and any changes to what has been written to the ledger will be detectable.

Blockchain technology has several strengths and weaknesses. Among the strengths are integrity protection (detects alterations), privacy protection, and increased efficiency, according to Lemieux (2017). She also lists the following weaknesses: lack of sufficient control, no link of records to business context, possible violation of data laws, uncertain admissibility as evidence, disposition is difficult, and long-term preservation is challenging,

As these new technologies emerge and mature, tech leaders and organizations will pay close attention to the viability and benefit each one provides.

Conclusion

Supply chain integration is almost essential for organizations to efficiently compete and grow these days. The amount of information and processes that are involved in many manufacturing and production environments today demand some level of automation to help speed the process and make it more efficient. This applies to all areas, including supply and distribution. Because of this need, new technologies are emerging to help make integration possible while providing benefits, such as increased efficiency, faster production, reduced cost, and higher customer satisfaction. When integration becomes complete from customer to delivery, everyone involved enjoys the benefits.

References

Bose, I., Pal, R., & Ye, A. (2008). ERP and SCM systems integration: The case of a valve manufacturer in China. Information & Management, 45(4), 233-241

Braun, G. (n.d.). How Technology is Reshaping the Modern Supply Chain (White Paper). Retrieved September 5, 2018, from C3 Solutions website: https://info.c3solutions.com/technology-reshaping-the-modern-supply-chain?utm_campaign=Logistics Management - April 2017&utm_source=email&utm_content=Technology White Paper

Dwyer, T. (n.d.). The Strategic Promise of SOA to Supply Chain Management. Retrieved August 30, 2018, from http://www.dbizinstitute.org/resources/articles/strategic-promise-soa-supply-chain-management

Lemieux, V. L. (2017). Blockchain Recordkeeping: A Swot Analysis. *Information Management Journal*, *51*(6), 20–27. Retrieved from http://login.libsrv.wku.edu:2048/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=lxh&AN=126356660&site=ehost-live

Misra, V., Khan, M. I., & Singh, U. K. (2010). Supply Chain Management Systems: Architecture, Design and Vision. *Journal of Strategic Innovation and Sustainability, 6*(4), 102-108.

Shen, W., & Norrie, D. H. (1999). Agent-Based Systems for Intelligent Manufacturing: A State-of-the-Art Survey. *Knowledge and Information Systems, 1*(2), 129-156. doi:10.1007/bf03325096

Supply Chain Management in the Cloud. (2014). Retrieved September 23, 2018, from https://www.accenture.com/t20150523T022449__w__/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Dualpub_1/Accenture-Supply-Chain-Management-in-the-Cloud.pdf

What is EDI (Electronic Data Interchange)? (n.d.). Retrieved September 9, 2018, from https://www.edibasics.com/what-is-edi/

Xu, L. D. (2011). Information Architecture for Supply Chain Quality Management. *International Journal of Production Research, 49*(1), 183-197.

Table 1

Benefits of using the integrated ERP and e-SCM system at Neway

Operational Measures	Pre-Implementation	Post-Implementation
Outbound order fulfillment		
Commitment to fulfillment percentage (%)	80	98
Average lead time (min)	45	30
On-time delivery percentage (%)	80	95
Inventory		
Average safety stock period (days)	40	25
Inventory accuracy (%)	85	99
Average monthly purchase frequency	50	10

Source: ERP and SCM systems integration: The case of a valve manufacturer in China. Information & Management, 45(4), 233-241