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# Developing a more robust approach to global supply chain information systems in a turbulent world

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# Developing a more robust approach to global supply chain information systems in a turbulent world

Abstract:

A global supply chain comprises producers, consumers, distributors, and retailers who may span trans-national boundaries. This paper reviews literature on global supply chains and offers recommendations about the key characteristics of a robust global supply chain information system. Issues related to standards diffusion at an international level are also discussed in light of the network effect theory. A review of an automotive supply chain case study (MOSS) has been presented to highlight the new approach to the effective use of inter-organizational information systems (IOS). Emphasis is laid on an industry standards approach that is non-proprietary and increasingly web-based.

*Keywords:* Agility; Cooperation; Global Supply chain (GSC); MOSS; Robust GSC model; Network effect theory; Open-standards

## Introduction

In an increasingly globalized economy, advanced means of communication and transportation have spurred a logistical revolution. This advancement in processes of how goods can be transported across geographical distances has enabled outsourcing to be commonly practiced. It is now possible to take advantage of lower labor costs and expertise available at any distant location in the world and maximize profits. Outsourcing and lower production costs have given impetus to the development of global supply chains (GSC). With the benefits of outsourcing and offshore production of goods in different stages of production, also come certain risks and complexities. The objective is to optimize and improve the GSC systems through better coordination made possible by information systems to reap the maximum benefits possible through greater efficiencies. By reviewing the relevant literature, this paper addresses the different vulnerabilities facing GSCs to develop a framework for thinking about information systems and information flows between supply chain members at an international level.

In today's increasingly connected world, changes are altering various customer-supplier relationships. New and advanced information systems are forming the backbone of global supply chain operations. The 21st century supply chain is electronically enabled. This does not automatically mean that they are efficient. In fact, a range of factors such as efficient information systems, flexibility, utilization of government incentives, transportation factors etc. combine to improve efficiency in supply chain operations (Prasad & Sounderpandian, 2003). The burgeoning and rapidly expanding international trade is often hampered due to inadequate support systems. From order procurement to timely logistics, efficient and integrated information systems are of paramount importance. Most importantly, being flexible in terms of the ability to rapidly realign GSC relationships is mandated through unforeseen disruptions and predicted

eventualities. The way forward is through having an agile, web-based industry-wide standardized system. A flexible supply chain based on such a web-based industry wide standardized system would be robust enough to deal with supply and demand shocks in an increasingly turbulent world. Such shocks can be in the form of a shortage of supplies due to natural or man-made disruptions and uncertainties.

A theory that can help us understand the need for and the potential benefits of an integrated and open standards based supply chain is the network effects theory (Katz & Shapiro, 1985). The network effects theory can form as the basis for robust global supply chain model. The theory suggests that the value of the overall supply chain increases as more members are able to join the GSC. An addition of a supply chain member that can provide the needed service when required in case of unforeseen disruption would add value to the overall supply chain network. In other words, utilizing services of members across supply chains can be quite useful for an organization. Overall supply chain robustness is enhanced due to open industry-wide standards that in-turn facilitate the possibility of relatively easy addition of new supply chain partners. In addition, standards play an important role in the overall adoption of information systems and actually even lead to wide-spread adoption of systems (Markus, Steinfield, Wigand, & Minton, 2006).

The goal of this paper is to build upon the literature on global supply chains and how we can learn from the issues related to standards diffusion at an international level in light of the network effect theory. In particular, the aim is to use an automotive supply chain case study to highlight the new approach for the effective use of inter-organizational information systems (IOS) and an industry standards approach that is non-proprietary and increasingly web-based. In

the automotive supply chain, the Materials Offshore Sourcing (MOSS) project is discussed to understand the efficiencies that were achieved in making a more robust GSC.

**Review of Literature**

Efficient supply chain encompasses benefits for all parties involved, which is possible through cooperation and information sharing. There is little disagreement that information sharing and vital data flow within the supply chain and company partners is possible through efficient information systems. The crux of the matter is how and what types of information systems are implemented. It is increasingly seen that organizations are deploying inter-organizational systems (IOS) to collaborate with their trading partners in their supply chain. "The network model involves outsourcing and collaborating in product or service delivery by establishing a platform for interaction and information sharing among partners" (Häcki, 2001).

Inefficient information flow can prove detrimental to the overall business functioning. Information asymmetry can create issues for the efficient functioning of the supply chain and can result in well-known issues such the bullwhip effect (Fiala, 2005). The bullwhip effect is a phenomenon whereby "a retailer's orders to their suppliers tend to have a larger variance than the consumer demand that triggered the orders. This demand distortion propagates upstream with amplification occurring at each echelon" (Warburton, 2004, p.150). In other words, demand variability increases as we move up the supply chain, and small changes in customer demand lead to big changes in orders placed upstream.

Managing the overall supply chain is a desirable objective for overall success. Supply chain management (SCM) involves managing the flow of products and information between the supply chain members. Efficient supply chain information systems are usually employed with a

competitive approach. This means that proprietary systems being used within a particular supply chain are often perceived by the members in the supply chain as providing them with a competitive edge; as such systems are unique to their group (Dyer & Singh, 1998). Firms may compete based on their unique information systems. This idea of competition based on unique information systems is in contrast with the modern day supply chain operations requiring a reevaluation of this traditional mindset. It is not about competing but about collaborating that could yield maximum benefits for all stakeholders within a GSC.

- **Advent of an open standards-based age in SCM**

In a supply chain, there may be multiple small and large business entities involved. By being part of the web-based supply chain system employing open standards, smaller-sized companies also move a step ahead by having an advantage over those companies still using the proprietary systems. These business partners may also be transacting with other business in different supply chains. A central issue arising here is concerned with the use of different information systems for different businesses. Not all members in the global supply chain especially smaller companies may be willing to participate in inter-organizational information systems (IOS). The cost of this investment in the form of systems implementation and employee training may be overwhelming. For example, it is noted that smaller organizations resist deploying Electronic Data Interchange (EDI) (Markus, 2005). From the small company point of view, dealing with various other large companies, such an entry into IOS may prove difficult and may require using multiple systems thus negating any potential benefits. It is often the dominant player in the industry that would have the leverage to implement a new system.

Even when IOS and EDI have benefitted organizations (Short & Venkatraman, 1992), (Williams & Frolick, 2001), often their implementation yielded little benefit. In the past decade, EDI's adoption was not widespread and only a small section of world's businesses had employed it (Segev, Porra, & Roldan, 1997). In the more recent past, the adoption of EDI especially in supply chains was not much different especially for smaller firms (Power, 2008). Amongst the different factors that have resulted in less than desirable implementation of these systems are high costs, lack of knowledge, few partners and resulting lack of interoperability (Tuunainen, 1998; Power, 2008). It may be due to such factors that we may see a resistance to the implementation of such systems.

In comparison with proprietary systems, open standards based IOS offer an alternative approach to supply chain integration and interoperability across partners. The uninhibited flow of information between the supply chain partners can possibly mitigate the effects of the bull-whip effect. Such an approach based on open standards based IOS also solves the problem of implementation of a standard by a dominant player in the industry as less resistance may be encountered when adoption of a standard is not forced. As the adoption of open standards gains momentum amongst organizations, network effects may set in, thus further strengthening the industry-wide standards adoption.

- **Risks and the need for better information systems**

While globalization offers various benefits to diversify and hedge against risks, it also proves to be the Achilles heel of the supply chain. As business processes are outsourced to economies further off-shore, complexity and risk increase. The global business environment may also prove volatile due to supply and demand shocks, natural disasters, price hikes and sea pirates. It is

imperative that businesses of today are more resilient in dealing with many global supply chain challenges. Supply chain risks can be classified in two broad categories: (1) supply chain coordination related risks and (2) supply chain disruption risks (Kleindorfer & Saad, 2009).

Highly coordinated flows of goods, services, information, and financial resources between and across national boundaries hold key importance in GSCs (Mentzer, 2001). Imperfect interoperability in terms of lack of coordination of information exchange in GSC is an issue that needs to be dealt with. In a GSC, coordination related risks can emanate from issues in forecasting which is linked to shortage or excess of inventory levels. Differing transit times on ports customs, tax and labor rate fluctuations etc. may add to the risks in supply chain coordination. In addition, accurate demand predictions, production planning, and order synchronization are all major tasks that gain more importance in a GSC scenario where exposure to risk is greater (Wagner & Bode, 2006). A NIST study found that more than $5billion was wasted annually in the U.S. automotive sector due to coordination issues such as forecasting, order cancellations, and shipment delays (White et al., 2004) .

Natural disasters and political instability can severely disrupt flow of goods and information (Barry, 2004). In addition, the vulnerability of the maritime sector from piracy has also been under discussion in various policy and research documents. Maritime piracy which is the act of committing theft aboard a shipping vessel often by armed gangs is indeed a crime affecting cargo supply-chain, and the entire network within supply chain. Statistics show that more than US $7.4 trillion worth of cargo moves across world's oceans (Biegon, 2009). A RAND corporation report indicated that waters around the Horn of Africa accounted for 38% of total piracy attacks in 2008. Another report published by a renowned British research institution, Chatham House, in 2008 also brings to attention the problem of piracy off the horn of Africa and

Gulf of Aden. The report mentions issues such as the potential supply chain disruptions and its negative impact in terms of cost of trade. Due to sea piracy, shipping lines may avoid that route and be forced to use longer routes thereby translating into cost-hikes as well as time delays (Middleton, 2008). Surprisingly, "other high-risk zones include the waters off Nigeria, Indonesia, Tanzania, Bangladesh, and India, which collectively accounted for 57 percent of incidents last year that were not related to the Horn of Africa" (Chalk, 2009). Therefore, losses related to piracy can result in huge burdens upon shipping vessel owners and operators, suppliers, and even consumers. These statistics point to the risks and vulnerabilities of global trade and possible supply chain disruptions that need our attention.

**Review of a case study of global standards-based supply chain IOS**

While risk reduction in GSC requires careful planning and coordination, visibility of the supply chain is vital for risk reduction. Furthermore, when change is required in the wake of unforeseen circumstances, agility is required to redesign the supply chain. To hedge against risks, it is not only the reliance on the supply chain partners that is important. It is equally important to have desirable control over the global flows. This in turn requires a good information system that can manage all global flows and partners in the supply chain.

It is important for information to flow freely and be shared in a GSC (Gunasekaran, Lai, & Edwincheng, 2008). This free flow of information at different points in the GSC is facilitated by the availability of low-cost Internet access (Pereira, 2009). According to the networks effect theory, benefits that adopters obtain from a network are positively related to the size of the network (Katz & Shapiro, 1986). An empirical study showed that the larger the network size, the stronger the incentive to adopt it and hence greater the value of the open-standard IOS (Zhu,

Kraemer, Gurbaxani, & Xu, 2005). The same study also found that "network effects and expected benefits are significant drivers of migration to open-standard IOS" (p. 20). Therefore, IOS open standards via the Internet have the potential to take advantage of network effects as transitions to such a system are less expensive and easier. Here it must be pointed out that information systems only are not the source of competitive advantage, rather a cooperative approach to supply chain IOS is a more successful approach (Steinfield, L. M. Markus, & Wigand, 2011).

The 2011 study by Steinfield, Markus and Wigand guides us to an ideal case in the long distance automotive supply chain. In focus were the efforts of Automotive Industry Action Group (AIAG), a non-profit group comprising automotive manufacturers, suppliers, technology vendors etc. The group aimed to promote standards development in the automotive industry. In 2006, AIAG started the Materials Offshore Sourcing (MOSS) project to "help in improving communication efficiencies in their growing global supply chain" (Steinfield, L. M. Markus, & Wigand, 2011, p. 2).

Key benefits of MOSS in a pilot study were achieving greater efficiencies in terms of data entry, cost and time saving, task reductions, reduction in shipment dwell times and buffer inventory levels, error reductions, visibility, and better compliance with customs regulations etc. For example, in comparison to the other system where only 21% of the data was reused, MOSS allowed 100% of the data entered at the outset of a shipment to be reused at a later point in the GSC (AIAG, 2009). The same study also revealed that tasks that needed to be performed reduced from 26 to 9; and that transportation assets could be used more efficiently and even redeployed for use with other customers thereby generating more revenue. All these efficiencies were only possible through MOSS due to the visible flow of information and an emphasis on

cooperation. In comparison to the traditional proprietary systems, standards-based approach to cooperation also lead to a more equitable and just distribution of benefits and costs amongst the supply chain partners thereby making it more likely to be adopted (Steinfield, L. M. Markus, & Wigand, 2011). In intercontinental shipments, "MOSS will address the inordinate amount of paper documents still used in the shipping process that has resulted in substantial delays in moving freight" (Onica, 2007, p. 13).

**Lessons learnt from the GSC literature**

Access to information when and where needed, adds to the strength of a GSC. This may be understood in the light of a perfect "lean market". According to this concept, any activity in such a market that does not create value is considered wasteful and therefore to be eliminated. Unconstrained flow of information within a distributed supply chain leads to a perfect lean market (Terry, 2007). A lean market is not only about faster production and waste reduction but enabling a manufacturer to have the right data at the right time so that response to problems with a GSC can be timely. MOSS initiative furthers vision of a perfect lean market (Onica, 2007). Onica (2007) points out three main attributes – clarity, agility and unity, as characteristics of a perfect lean market. Agreement on a common way to communicate between business partners via standards leads to seamless communication having clarity. The agility characteristic enables organizations to respond to changes through real-time automated information flow thus improving decision making. Unity is defined as the collaboration or "effect of cooperation between manufacturer and suppliers" (Onica, 2007, p. 13).

IOS standards that are easily adopted in a GSC would help mitigate the effects of any unforeseen risks. A supply chain disruption as and when it happens would be easy to deal with if

there is flexibility in the supply chain emanating from common standards that allow the supply chain to be re-engineered in a short span of time. Here, we can understand the application of network effects where a large number of members in a supply chain would further ease the possible reconnection of a missing link due to any disaster or any of the risks mentioned earlier.

There may be some smaller firms that may not be interested in investing in global supply chain relationships due to the cost barriers and the extra effort involved in becoming part of a proprietary system. Here, it can be understood that the argument for a web-based system holds even more value as it is easier for smaller firms to enter into systems that have open standards and are also Internet based. This is in sharp contrast to proprietary based systems that may prove costly for smaller firms to adopt.

At a global scale, adoption and diffusion of standards amongst foreign partners can be challenging. In case of the proprietary systems, the implementation of standards at a local level seems more than daunting and such an endeavor at an international level involves even more challenges. However, due to the nature of the open standards – they impose lesser costs on the members - it is very likely that they will be adopted in the GSC. As discussed earlier, this is also evident from the MOSS example. Open standards diffusion provides the ability to absorb disruptive supply chain shocks through visible information flow throughout the supply chain.

To better deal with risks at both the organizational level and across the overall supply chain, the key to success lies in better coordination, collaboration and cooperation (Kleindorfer & Saad, 2009). It is worth mentioning that the emphasis is not on businesses competing individually but on competing as whole supply chains systems. This is made possible by the utilizing of web-based services whose ubiquitous reach may bring many different types of firms

into the fold. In non-cooperative scenarios, a win-win outcome seems less probable as managing risks and disruptions can prove costly, and overall supply chain synergies seem distant (Kleindorfer & Saad, 2009). This makes open IOS diffusion even more imperative.

The MOSS case helps us understand GSC, which is web-based, and the system that can be seen as software as a service. The standard also resulted in significant labor and cost savings due to a reduction in tasks. Without the MOSS standard, data needed to be rekeyed at several points, causing time delays as well as potential errors. Therefore, MOSS served as the vital link that ensured a truly lean market in which the entire supply chain was visible.

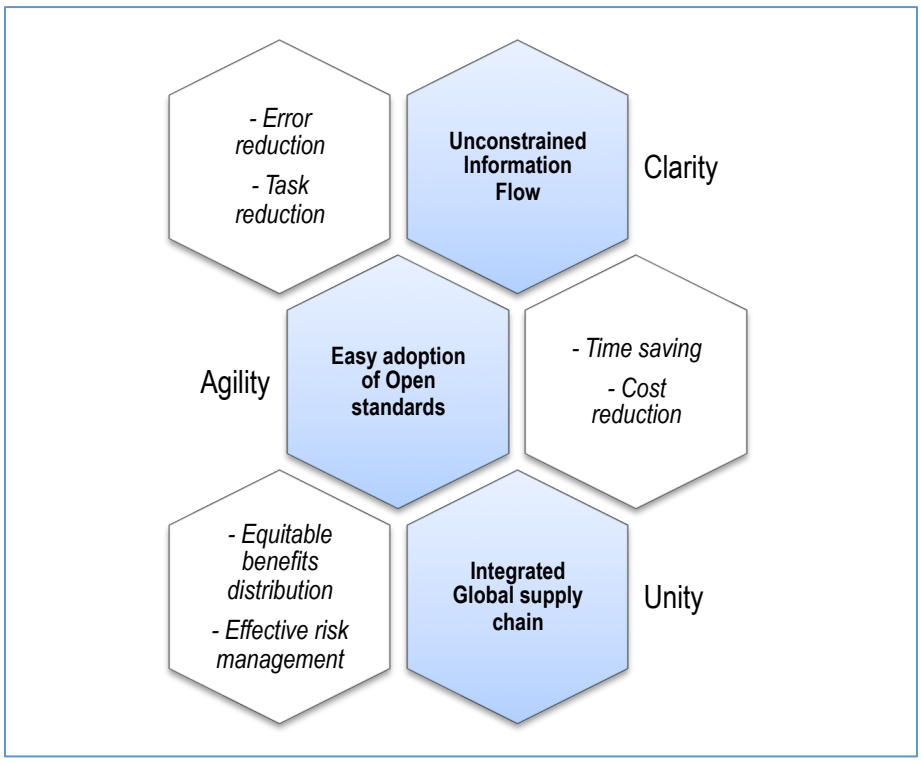


Figure 1: *Robust global supply chain model*

The discussion leads us to the robust global supply chain model as depicted in Figure 1. This model gives a clear picture of benefits arising from the adoption and diffusion of open

standards in a globally integrated supply chain. The following model has been developed in light of Onica's (2007) characteristics of a perfect lean market.

Based on common open-standards that are adopted by firms, unconstrained flow of information within business partners in a supply chain leads to seamless integration of data flow and efficient communication thus contributing to overall clarity. Easy adoption of open standards spurred by utilization of network effects benefits allows for a larger number of firms in the global supply chain. The adoption of open standards allows business partners to respond to changes through real-time automated information flow thus improving decision making. An integrated supply chain emanating from open standards adoption leads to better coordination amongst the partners thus enabling a more equitable benefits distribution and effective risk management. Clarity, agility and unity combine to create a robust global supply chain. Such a robust supply chain has the capability to essentially handle disruptions in the supply chain with great flexibility and readjustment.

**Future Directions**

Communication technology has taken supply chain management to the next level. Further advancements in technology are set to improve GSC operations. In particular wireless communications systems allowing increased mobility and portability and the resulting real time access to information has the potential to positively impact GSCs. In different parts of the supply chain, employees can now track their products over mobile devices (J. V. Chen, Yen, & K. Chen, 2009). In the presence of wireless access points or hotspots, data could be instantly collected from the field and made available to all on the GSC. This would help not only in data collection but also instant decision making to ensure the most optimal route for a shipment etc.

Management of shipment flows and handling of disruptions can also be streamlined. The advancement in mobile technologies in terms of more computing power, storage, advanced applications and better graphical interfaces are also set to strengthen the GSC even more. This is in line with the concept of Internet or web-based supply chain systems. Electronic commerce due to the availability of "always on" Internet at any location can further make the flow of information flow in the supply chain more efficient. For example, real-time inventory locating systems and asset tracking during shipments further increase the visibility of the supply chain amongst its members would add to the robustness of the GSC.

**Conclusion**

A robust approach to an integrated global supply chain is the way forward. Supply chain systems need to be robust at a global level so that it is relatively easy to connect across supply chains given any disruptions. In the 21st century economy, customer expectations and the way business is conducted are changing. Product customizations and uneven demand is forcing organizations to adapt and maintain their competitive advantage. On the other hand, companies are facing an increasingly uncertain environment. The traditional approaches to maintaining a supply chain are becoming outdated and even detrimental to survival in the age of shrinking profits. The focus has shifted towards cooperation within the supply chain instead of competition. Internet technologies in particular and an open standards approach would prove to be the way forward. Collaboration with business partners, while harnessing the power of the technology is already proving to be fruitful in creating agile and efficient supply chains.

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