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Abstract

Although Radio Frequency Identification (RFID) implementation faces a host of challenges, Wal-Mart perseveres in its drive for RFID adoption throughout its supply chain. By being such early adopters of RFID, Wal-Mart's suppliers suffer increased costs which put pressure to bear on their profitability. In the face of the additional costs of RFID, why has Wal-Mart chosen to mandate the use of RFID tagging in its supply chain and insisted on such a short implementation period? This paper reviews Wal-Mart's relationship with its supply chain, describes Wal-Mart's RFID initiative, and proposes a possible unexpressed motivation underlying Wal-Mart's drive to go to RFID. Early results are indicating incremental improvements at Wal-Mart due to RFID implementation; however, the argument can be made that Wal-Mart's ultimate goal is an innovative improvement on a Schumpeterian scale – the desire to radically improve an important supply chain metric, the cash-to-cash cycle. This reasoning supports fertile areas for future research in the relationship between RFID and the Cash-to-Cash Cycle.

Introduction: Supply Chain Metrics

Supply chains consist of companies bound by trade with each other, and stretch from the initial raw materials to the finished product placed in the consumer's hand. Supply chain companies recognize the critical role partnership plays and the impact that a firm's suppliers and customers can have on its operational and financial performance.

AMR Research listed the top 25 supply chain firms in a report called "The AMR Research Supply Chain Top 25 and the New Trillion-Dollar Opportunity" (Friscia, et al, 2004). The basis of the report is that supply chain superiority is crucial to the success of companies operating in today's competitive environment, and that superior companies are following a model AMR dubs "Demand-Driven Supply Network (DDSN)." Table 1 contains the data reported for the top 5 vendors on AMR's list.

There are notable findings in these ratings. Dell Computer has a composite score significantly higher than its next highest competitor. The composite scores for the next four are closely clustered, with IBM and Wal-Mart in a virtual tie. Of the financial ratios, the most startling is Dell's Sales/Inventory ratio of 126.7. Dell uses a unique business model capitalizing on the use of the Internet and Just-in-Time manufacturing. The extremely high Sales/Inventory number reflects Dell's superb leveraging of the material costs that are needed for each sale. Of the top five firms in AMR's study, Wal-Mart had the lowest Sales/Inventory ratio and the lowest Return on Assets, a ratio also related to a firm's ability to leverage its inventory.

The AMR report states that the four most critical metrics a company can use to evaluate its own supply chain are "demand forecast accuracy, perfect-order fulfillment…, supply chain cost, and cash-to-cash cycle time." This last, cash-to-cash cycle time, is a corollary to the Sales/Inventory ratio, and a paramount measurement of the effectiveness of a company within a supply chain (La Londe, 2004; Murphy, 2004). It represents the elapsed time between a company's payment for material purchased from a supplier and receipt of payment for that material when sold to a customer. Between 1995 and 1998, best-in-class supply chain companies reduced their cash-to-cash cycle times by 18 percent ("Top Performers", 1999). Dell Computer is legendary for its ability to achieve a negative cash-

to-cash cycle from its operating model. In 2004, Dell had a negative 36 days cash-to-cash cycle, meaning that on average, Dell collected payment from its customers 36 days before it paid its vendors (Murphy, 2004).

Table 1. AMR Research Supply Chain Top 25 Report[1] (Excerpt).

	Vendor	AMR Research Opinion (40%)	ROA (20%)	Sales/Inventory (20%)	Trailing 12 Months Growth (20%)	Composite Score
1	**Dell**	238	13.7%	126.7	17.1%	20.75
2	**Nokia**	145	15.0%	25.2	17.5%	13.31
3	**Proctor & Gamble**	188	10.7%	11.9	7.8%	11.70
4	**IBM**	137	13.5%	29.3	9.8%	11.31
5	**Wal-Mart Stores**	175	8.5%	9.8	10.9%	11.27

It is significant that the top four positions were occupied by manufacturers – supply chain theory has its roots in understanding how manufacturers work with both customers and suppliers to achieve efficiencies. Of AMR's 25 suppliers, 72% are manufacturers (Friscia, et al, 2004). Although retailers in the supply chain benefit from a reduced accounts receivable (sales are made on a cash or credit card basis which shortens the collection side of the cash-to-cash cycle), they are hampered by the need to stock items that might or might not be purchased by consumers. Every day and hour an item sits on a retailer's shelf increases the cash-to-cash cycle on the payables side. The very nature of retailing requires goods to be available for sale for some period of time before the consumer makes the purchase, so it is remarkable that eight retailers are included in the top 25. At number 5, Wal-Mart is the highest ranked retailer (Woolworths is the next highest at number 12).

Wal-Mart and its Supply Chain

From its inception, Wal-Mart recognized the need for discount pricing (Moore, 1993). In the 1980s, as Wal-Mart grew to a size that gave it bargaining power, it began to pressure its vendors to keep costs down. As early as the 1970s, Wal-Mart invested in its distribution systems, taking advantage of economies of scale and scope; from the 1980s through today, Wal-Mart has recognized that distribution is a crucial element in its success. Wal-Mart is geared towards continually scanning the environment in search of new opportunities to reap benefits from its supply chain. Ongoing uses of supply chain efficiencies to keep costs, and therefore prices, down allow Wal-Mart to boast of "Every Day Low Prices."

RFID Initiative

RFID is the latest technology that Wal-Mart has identified to achieve incremental gains in supply chain efficiency. RFID uses an Electronic Product Code (EPC) recorded in a microchip which can be read remotely, unlike barcodes which are printed labels and require line of sight to be read. The EPC uniquely identifies the tagged item rather than merely providing its UPC product code, and is tied to data stored in corporate databases (Lazar, et al, 2005). In June 2003, at the Retail Systems 2003/VICS Collaborative Commerce conference, Wal-Mart announced that it was requiring its top 100 suppliers to be able to apply RFID tags to cases and pallets by January 2005 (Seideman, 2003; Vijayan, 2003).

[1] **AMR Research Opinion** from panel of experts ranking firms against the definition of "DDSN Orchestrator."
Return on Assets: 2003 Net Profit/2003 Total Assets
Sales/Inventory: 2003 Sales/2003 Year-End Inventory
Composite Score is the weighted average of the four metrics. (Friscia, et al, 2004)

At the time of the announcement, Wal-Mart suppliers and information technology vendors were apprehensive because of the perceived challenges in manufacturing, pricing of the tags and standardization (Vijayan, 2003). Wal-Mart, on the other hand, forecasted that the RFID initiative would provide major benefits. It anticipated a 5 percent inventory reduction, a reduction in the rate of stock-outs with a corresponding increase in sales, and reduced store and warehouse labor costs (Seideman, 2003). Kerry Pauling, Wal-Mart's director of information systems enthused, "RFID will not just transform, but will revolutionize the way we do business and deliver unimaginable benefits…it's not about the technology; it's about the data." (Leach, 2004).

Concerns with RFID

Suppliers balked at the RFID edict because they saw an increase in their costs without any corresponding benefit. The problems with RFID adoption have been well documented elsewhere (Field, 2005, Lazar, et al, 2005; Leach, 2004). Although the mandate by Wal-Mart and others have resulted in lowered costs, the RFID tags are still very costly in comparison to bar codes. There are also technical problems with RFID; for instance, the signals do not penetrate liquid or metal (Leach, 2004). At the time of Wal-Mart's announcement, there were two vying standards, one being developed by ISO and the other supported by Wal-Mart. Additionally, there were conflicts with the radio frequencies used by RFID in the United States and frequencies used abroad, a serious problem for a global retailer.

Additionally, the need to redesign business processes presents a major obstacle to the effective deployment of RFID tags. Rather than undergo these very time-consuming and resource intensive exercises, some vendors were simply tacking on an additional step to the end of their processes to attach the RFID tags. In fact, UPS elected to stay with bar codes and use a wireless scanning system because it recognized the need for business process reengineering if RFID were to be deployed (Mashburg, 2005). Robert Nonneman, a UPS industrial engineering manager, stated, "You can't simply replace optical scanners with an RFID reader and expect an improved return on investment… there have to be process changes to leverage the technology."

Even as late as 2005, RFID's lack of ability to deliver as promised at an acceptable cost has been a source of disappointment for many companies (Field, 2005). The high costs of current-generation equipment and tags still present an obstacle for deeper penetration in the supply chain. Suppliers wonder how they will achieve return on investment.

Strategic Implications of RFID Implementation

In light of the very real concerns about the costs of RFID implementation, why did Wal-Mart see the need to push so strongly for this technology and accept the resultant wrenching changes in its operations and the operations of its supply chain? A report published in APICS magazine combined with an understanding of supply chain metrics provides a possible answer.

Potential Strategic Benefit

As reported in APICS magazine (Weil, 2005), at a conference held in September 2004, Wal-Mart enticed its suppliers by offering them access to point-of-sale (POS) information in return for supplier implementation of RFID. Currently, Wal-Mart sends demand information to its suppliers from its checkout data collection systems; the intimation at the conference was that suppliers would be privy to the movement of their RFID-tagged products through Wal-Mart's internal supply chain all of the way to point-of-sale. Suppliers recognize the potential for RFID to "effectively address a critical issue – visibility of inventory in the supply chain." (Field, 2005). This visibility would allow manufacturers to dramatically improve one of the four crucial metrics cited by AMR, demand forecast accuracy.

There was a catch. According to Bruce Hudson, an RFID analyst at META Group, in return for complete visibility of individual items throughout the supply chain, Wal-Mart wants the product to remain the suppliers' inventory until it has been scanned through POS (Weil, 2005). Since RFID can indicate the specific iteration of the product being sold, Wal-Mart would be able to send its supplier notice of the sale, simultaneously record the purchase and sale of the product against Wal-Mart's inventory, and pay the vendor on some pre-agreed upon schedule. The ability of

RFID to support this process makes it clear why Wal-Mart needs RFID even though there have been significant advancements in barcodes. New abilities to encode more data by using 2D and 3D symbology, the development of scanners that can read at a significant distance from the barcode label ("Mobile," 2005), and scanners that can make multiple simultaneous reads ("Better," 2005) have not supplanted the unique ability of RFID to permit granular identification of individual, specific items.

The implications of this change are dramatic. Being able to leave the inventory in the vendor's account until POS would allow Wal-Mart to achieve a quantum increase in financial performance because it would substantially improve its cash-to-cash cycle. Our earlier discussion identified how important this metric is to a successful supply chain company. Implementing the full potential of RFID would provide a major competitive advantage for Wal-Mart over its competition, giving it a cash-to-cash cycle of zero and or possibly, depending on vendor terms allowing aggregation of payments, even a negative cash-to-cash cycle, a phenomenal feat. Wal-Mart would free a substantial cash flow which could be used to fund other activities or to pay down debt. RFID is the key to this accomplishment.

When could Wal-Mart reap the ultimate RFID benefit?

The first impacts of RFID on Wal-Mart, as evidenced by a study conducted over 29 months by the University of Arkansas ("Study of Wal-Mart", 2004), has been positive, and the results align with published predictions. In comparing 12 pilot stores with 12 control stores, the researchers determined that stock-outs were reduced by 16%. The items that did go out-of-stock were replenished three times faster in the stores that deployed EPC tagging than in the control stores. It appears that the groundwork needed to achieve complete supply chain implementation of RFID is progressing. However, it will be some time before Wal-Mart will be able to join the elite company of Dell with respect to cash-to-cash cycle improvements from RFID. Technical issues, costs, and privacy issues stand in the way, as can been seen by the experiences of other retailers who have ventured closer to item level tagging.

In 2003, Metro Group opened a Future Store located in Rhienberg, Germany in which it tested the use of RFID tags that would allow all items at checkout to be scanned simultaneously ((Tarnowski, et al, 2005). Working with firms such as Kraft, Gillette, and Proctor & Gamble, Metro tested items such as shampoo, razor blades and cream cheese (Stankevich, 2004). From its experience, Metro has determined that the cost of chips needs to fall significantly before being practical in wide use and therefore does not plan to deploy item tagging on a broad level for another 10 or 15 years (Douglas, 2005).

There are also concerns about privacy (Lazar, et al, 2004). Several advocacy groups warn that consumers taking their EPC-tagged purchases out of the store could be tracked by those who have in interest in gathering data about them such as market researchers or law enforcement agencies (Douglas, 2005). Metro Group acknowledges the need for deactivating the tags, but does not have a device able to quickly and automatically disable them upon customer exit. Marks and Spencer, a United Kingdom retailer, is using item level RFID tags for men's suits, but limiting its use to inventory control ("Marks & Spencer," 2005). The initial paper EPC passive tags will be integrated into bar code labels with a notice "Intelligent label for stock control use" that Marks & Spencer hopes will satisfy privacy advocates. The tags will not be used at checkout.

It is possible that practical solutions will be found sooner than previously thought. Researchers are actively looking for ways to protect consumer privacy that are practical and user-friendly. As an example, a proposal for a tag which can be deactivated by clipping the antenna promises ease of use for the consumer with minimal additional cost (Karjoth, et al, 2005).

Conclusion

The RFID story is far from being over. While item level EPC tagging is possible, technical, cost, and privacy issues will defer its adoption to some time in the future. Nonetheless, with the successful completion of the initial phase of RFID implementation by 138 Wal-Mart suppliers, the technology is on its way.

This paper argues that Wal-Mart's motive for the forceful adoption of RFID in its supply chain is to allow the retail giant to catapult to a zero or negative cash-to-cash cycle which would give it an enormous competitive advantage

over its competition and entrench its ability to continue offering Every Day Low Prices. Future research directions suggested by this argument include evaluation of feasibility of RFID through point-of-sale, empirical study of the relationship between RFID and the cash-to-cash cycle, and understanding the benefits and drawbacks to suppliers by participation in the program described.

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