The Value of RFID in Transportation:  
From Greater Operational Efficiency to Collaborative Transportation Management

Radio Frequency Identification (RFID) is not a new technology: it was first used during World War II, and is frequently used currently, at automatic tolls or to enter secure areas. Thanks to new technical capabilities, such as chip miniaturization and the Internet, new and promising applications are emerging. It has been extensively announced that massive use of RFID throughout supply chain will revolutionize its functioning and significantly improve its performance in the coming years.

An abundant literature has been produced on the subject recently. Yet, in further investigating the broad scope of supply chain activities, we noticed that the use of RFID in transportation does not raise as much enthusiasm as it does in other areas. It is neither easy nor clear to find the reasons for this lack of interest, but it is likely that most analysts face difficulties in identifying and quantifying intrinsic and cross-functional gains.

This paper assesses the value of RFID in transportation forecasting, planning, and execution processes for truckload (TL) and less than truckload (LTL) services. First, we have carried out a thorough analysis of these transportation sub-processes and have assessed whether there might be opportunities to enhance their efficiency and performance by using RFID. Then, we have evaluated if this use may globally be beneficial for all players, i.e. the carrier, the shipper and the consignee, and not only for some of them. Finally, we have examined how RFID-enabled transportation may positively impact other logistic processes, such as inventory management. Beyond involving only technical aspects, the two latter points address organizational issues and involve prerequisites to RFID implementation, in particular in terms of collaboration.

Scope, assumptions and approach

The scope of the study goes from shipping to receiving, through transportation and consolidation in cross-docking terminals, focusing only on the US TL and LTL industry. We assume that RFID tags are applied at case or pallet level, that tagging is performed "at source" by vendors on all products, and that technical problems are solved, meaning that systems allow 100% perfect reads, that there will not be any interference or interoperability problems. Finally, we suppose that available RFID-generated information is shared between players through the EPC network.

In order to perform our study, we have conducted an in-depth analysis of every transportation sub-process. We have decomposed each of them into elementary components, described the three players' role and their mutual exchanges. Further, we have identified the main problems they confront and their causes, and we have assessed first, if RFID may be of interest to improve the current situation, and second, what value is generated by the changes. To present our results, we have grouped the forecasting and planning sub-processes in a single process, and have divided up the execution process in two sub-processes, for TL and LTL carriers.
RFID and the transportation forecasting & planning processes

Difficulties in transportation forecast and planning mainly stem from poor data synchronization between players, use of old information and deficient coordination between shippers, consigneers and carriers. When used very upstream in the forecasting process, RFID should permit more accurate inventory management at shipper's and customer's DCs, and in customer's stores' backrooms. It should help to lower the product order forecast variability, and, as a result, permit a more precise shipment forecast.

In terms of prerequisites, investments are mainly on the shipper's side, with tags and readers, and partly on consigneer's side, with readers, but not on carrier's side. Note that carriers will benefit from precise shipment forecast only if products are comprehensively tagged by vendors. From an organizational point of view, setting rules on information sharing between vendors and customers, and transmitting the results to carriers, will constitute an important challenge.

If all prerequisites are satisfied, benefits are great for all players. Beyond a better match of demand, shippers have less recourse to expedition. Consigneers reduce their stock-outs and subsequent lost sales. Carriers better plan their long-term capacity and their short-term asset utilization, which leads to fewer lost sales. Comparing benefits and investments, we obtain different value levels for each player: moderate for shippers, high for consigneers, and even higher for carriers, as they do not have to invest at all. However, if we consider that shippers had already invested in RFID for other purposes, the value may then be high for them too.

We must emphasize that the formalization of procedures and the setting of rules on information sharing between the three players is critical, for this process to be enhanced. It should be greatly facilitated if all of them become involved in Collaborative Transportation Management (CTM), whose objective is precisely to formalize tasks and promote communication.

RFID and the transportation execution process for TL carriers

Problems in TL transportation come, first, from human errors on data keying, counting and loading, and second, from documentation errors. RFID will permit task automation and reduction or suppression of time spent on verification, and will enable an automatic generation and transmission of documents. Mis-loading and misrouting will be avoided or reduced, thanks to readers installed at portals. Error reduction will lead to a better On-Time Delivery (OTD) rate, which will in turn lower the average transportation lead time, and, more importantly, decrease the lead time variability.

These capabilities will entail three major benefits. First, task automation will result in notable labor cost reduction. In the long run, shippers should be able to reduce their auditor costs by 100% and their clerical costs by 30 to 50%. Consigneers should lower these costs as well, to a lesser degree, as fewer documents will be automatically created. Due to a reduction of loading and unloading time in case of live load/unload, carriers may be able to slightly reduce drivers' costs. All players will see their reconciliation costs reduced. The second benefit is the
significant improvement of data quality and shipment visibility due to the automatic production of documents: a better service will be provided by shippers, which will help to better plan and manage the workforce at their facilities and at consignees' ones. The third benefit, which concerns only shippers and consignees, is linked to the decrease of mis-loading and mis-routing. The diminution of lead time variability will lead to a reduction of their safety stocks. Our calculations show that when an OTD rate passes from 90% to 98%, the safety stock is reduced from 20% to 35% (for a 3-day trip and a 1-day trip, respectively).

In technical and financial terms, the prerequisites are basically the same as in forecasting. An important difference, however, is that RFID implementation will not need to be comprehensive for this process. Selectivity can apply to products, routes or targeted vendors or customers, which may help to lower required investment. For this process, the value for the shippers is moderate to high, the benefits being very high, but investment being high too because of products' tagging (again, except if tagging had been done for other purposes). The value is high for the consignee, as its investment is moderate, whereas its benefits are very high. The value for the carrier is relatively small (weak benefits, but no investment).

RFID and the transportation execution process for LTL carriers

Problems in LTL transportation are mainly due to its multi-stage and sequential nature, which may potentially lead to an accumulation of delays in pick-ups, line hauls and deliveries. LTL carriers are confronted with the same problems as TL carriers in data keying, counting, loading and documentation in their terminals, but risk of error is multiplied by the number of break loads. RFID will suppress data entry for the internal waybill at the first terminal, and automate the verification of sorting and pooling at every terminal. If a certain number of the shippers and customers that are included in the pick-up and delivery cycles are also equipped with RFID, delays in goods' preparation or docks' unavailability may be announced, allowing for a dynamic change of delivery or pick-up routes.

We identify three main RFID benefits in LTL transportation. The first one is a labor cost reduction within LTL terminals, with fewer auditors, clerks and reconciliation specialists. Second, RFID will enable a faster and more accurate creation of waybills and delivery notes at the first and last terminals, ensure an errorless sorting of shipments through portals, and allow shipment prioritization in case of emergency. More than in TL transportation, on-time delivery rates should significantly improve, reducing considerably the lead time variability, and diminishing in turn the safety stocks at shippers and customers. Our calculations show that when an OTD rate passes from 75% to 95%, the safety stock is reduced from 25% to 40% (for a 5-day trip and a 1-day trip, respectively). Third, when a sufficient proportion of shippers and consignees are equipped, there will be a better productivity for drivers who perform local deliveries and pick-ups. Realistic assumptions in terms of better regularity in local operations, i.e. less variability in operating time at shippers and consignees, lead to a reduction in the number of drivers of up to 10%. This reduction applies also to the assets managed by the terminal.
The prerequisites in the case of LTL carriers are very critical. If we consider the three benefits cited above, the two first (labor cost and lead time variability reduction) can be obtained for carriers only if all their terminals are fully equipped with RFID. That means that they must have not only the readers installed, but also tagging capabilities, in order to allow non-initially-tagged products to be tagged within the LTL facility, further routed and followed up through the LTL network. The drivers' productivity and reduction of assets could be achieved without investments in terminals, but would require that most products be tagged "at source", and most shippers and consignees involved in the delivery and pick-up cycles be equipped.

For shippers and consignees, the value of RFID in this process is identical if their goods are transported by TL or LTL carriers. The value for the LTL carrier will differ significantly according to its level of investment. If investments in terminals are massive, the benefits will be high. But both high investments and benefits do not necessarily mean high value. The critical parameter to evaluate, by type and size of terminal, is the potential workforce reduction level. In the long run, the value should be high, a "one-time investment" generating durable gains in terms of personnel. As RFID implementation needs to be compressive to be worthwhile, it is critical first to well evaluate the gain, and second to perform a detailed discounted cash flow analysis, in order to assess the return on investment. If the carrier does not invest in terminals, but takes only advantage of shippers' and consignees' investments, the value should be moderate, as it would also take time for shippers and consignee to be fully equipped.

**Assessment of findings**

Roughly, it appears that every player can draw some benefits from RFID. Each sub-process can more or less profit from RFID benefits, i.e. less labor, higher speed and better accuracy, but players do not always reap them in the same process. Consignees are not surprisingly the most likely to benefit from RFID in transportation (it has been regularly denounced by vendors since the announcement of the Wal-Mart and DoD mandates). But all in all, every player gets at least one high value sub-process, and a globally positive value on the whole transportation process. Moreover, we found that an investment by one player could benefit another player. This may be illustrated by the few following examples.

(1) Beyond enhancing its own efficiency, an investment by a LTL carrier in its own terminals induces less variability in transportation lead time and leads to a safety stock reduction for both shippers and consignees. (2) Investments by shippers and consignees reduces operating times' variability in their facilities, enhancing drivers’ productivity and enabling a better utilization of carriers' assets. (3) RFID-enabled product forecast, generated in common by shippers and consignees, goes beyond a better matching of supply and demand; when converted into shipment forecast, it helps a carrier to better plan its capacity and manage its assets. It entails a reduction in expedited shipments for the shipper and fewer stock-outs for the consignee as well.

These examples give a good idea of the potential improvements that collaboration could bring. We have already pointed out how core RFID benefits (better visibility in execution, more accurate data for reconciliation, etc…) may enable collaboration. Our previous examples show
that these "cross-benefits" should prompt players to find a way to share investments in order to share benefits, and that this collaboration is critical to fully take advantage of RFID-generated data. Collaborative Transportation Management (CTM), an approach that promotes and organizes this collaboration, already exists. CTM is a continuation of CPFR which includes the carrier, and primarily sets information sharing rules. CTM implementation requires a pro-active attitude on the part of the players, but it may be done smoothly by adopting a selective and step-by-step approach.

To conclude the paper, we may note that we were confronted with several difficulties in this research: a very broad scope, which covered several sub-processes and dealt with three players; different situations and processes according to the companies we studied; limited access to information on costs (tags, readers and software) and on companies' official metrics. The conclusions of the research are consequently rather qualitative. They need to be confirmed by more focused and detailed studies.