

## What is RFID Worth to Your Company? Measuring Performance at the Activity Level

**Robert Laubacher**, *Research Associate, Center for Coordination Science*

**S. P. Kothari**, *Gordon Y Billard Professor of Accounting*

**Thomas W. Malone**, *Professor, Director of the Center for Coordination Science*

**Brian Subirana**, *Visiting Associate Professor*

Leading global retailers like WalMart, Target and Metro have recently launched initiatives requiring their major suppliers to implement radio frequency identification (RFID) technology. RFID tags are in line to become the bar codes of the 21st century, allowing manufacturers and retailers to track items moving through the supply chain more quickly, cheaply and reliably. Bar codes came into widespread usage in the 1980s and by 1997 were generating over \$15 billion in annual benefits for the \$300 billion U.S. grocery industry.<sup>1</sup> RFID has the potential to spur an even broader and deeper revolution in supply chain practices.

Managers who must decide today on whether and how to implement RFID face large up-front investments, with payoffs that look small in the short term and uncertain in out years. In addition, the range of possible approaches is bewildering: Should firms launch pilots at a small number of key sites? Tag only shipments bound for retailers that require RFID? Or pursue rapid, broad implementation to gain a lead on competitors?

This article focuses on an implementation where tags are applied to cases of goods at a consumer goods manufacturer's factory. Implementations like this are expected to be the most common type during the first wave of RFID adoption.

<sup>1</sup> Benefits of bar codes from Alan L. Haberman, ed., *Twenty-Five Years Behind Bars: The Proceedings of the Twenty-fifth anniversary of the U.P.C. at the Smithsonian Institution, September 30, 1999* (Cambridge, Mass and London: Harvard University Press, 2001), 13-19, 150-151.

Managers considering RFID investments could use a reliable way to measure the potential costs and benefits of their various options. A new tool we are developing - Activity Based Performance Measurement, or ABPM - can help. ABPM can assess business performance at the activity level and then aggregate these fine-grained metrics upward to the business unit and firm level. ABPM is more flexible and leverages insights gained during the measurement effort more effectively than traditional, project-based return-on-investment approaches. It also offers greater visibility into where in the supply chain benefits will be achieved, thus providing guidance for managing the implementation and negotiating with supply chain partners. The RFID investment decision, with its complexity and high stakes, is a problem well-suited for ABPM.

### Key insights behind ABPM

ABPM is based on two insights. The first is that costs come mainly from an activity's parts, while benefits usually result from how an activity affects other activities. As a result, measuring costs is relatively easy, but measuring benefits is hard. The second insight is that there are common patterns in the types of benefits associated with activities that have similar underlying characteristics. We call these common patterns *family resemblances*.

1. **Costs from parts, benefits from effect on other activities.** Calculating the costs of an activity is a matter of decomposing it into constituent parts, determining the cost of each part, and aggregating those costs.

The benefits of an activity usually arise from how it affects other activities in the value chain. For example, quality programs reduce product defects and so reduce costs associated with factory rework and staffing customer service units. Higher quality can also increase future sales, due to greater customer satisfaction and enhanced firm reputation.

2. **Family resemblances—Common patterns in the kinds of benefits associated with similar activities.** It is difficult to consider all the possible benefits that an activity can generate

and develop systematic approaches for estimating those benefits in every instance. ABPM seeks to gain leverage on this problem by taking advantage of the underlying similarities that exist between many activities that take place in business. For example, checking the quantity of goods is an activity that takes place at many junctures in the retail supply chain. Quantity checks of this sort occur at the receiving dock of the manufacturer's warehouse, when shipments arrive from the factory; at the manufacturer's loading dock, when shipments are placed on trucks for transportation to the retailer; at the retailer's distribution center, when the truck arrives; and so on, all the way to the point where the consumer makes a store purchase, and the clerk checks the quantity of each item in the shopper's cart. The underlying similarities between these different specific activities allow us to create a family tree, whose root is the general activity "check quantity" and whose branches include ever more specific instances.

**How ABPM works**

Managers can use ABPM to assess the impact of a new technology, such as RFID, or a management intervention of any sort. ABPM can help in estimating the potential costs and benefits to make pre-implementation decisions, and it can also provide post-implementation measurements of actual benefits achieved. Using ABPM to assess the impact of a new technology like RFID involves four primary steps:

1. **Develop potential post-implementation scenarios.** Deciding how the activities in question could operate if enabled by the new technology. This article examines a single, straight-forward scenario, with RFID enabled counting replacing barcode scanning.
2. **Identify activities affected by the new technology.** High level activity map. Top level activities are then decomposed to identify sub-activities affected by the technology. (see Figure 2)

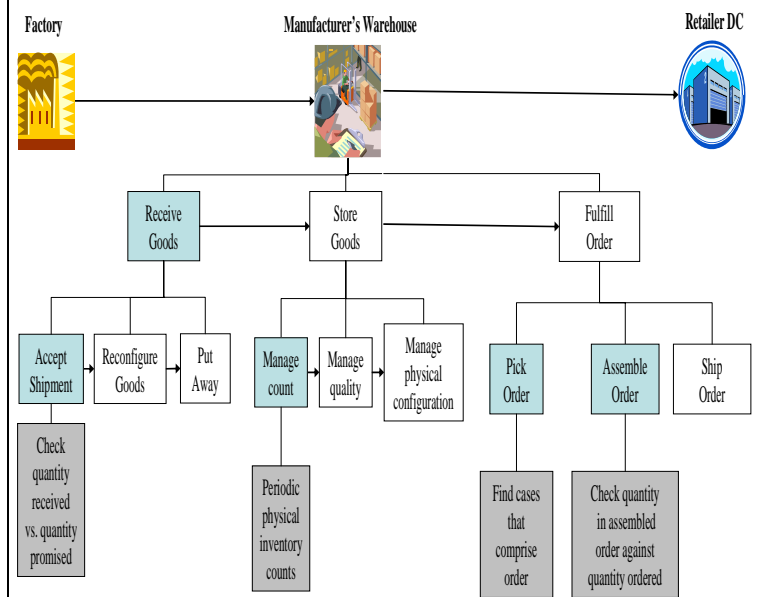


Figure 2: High level map of retail supply chain

3. **Map the activities with vs. without the new technology.** Mapping the activities prior to implementation and then as they will be executed post-implementation. It compares how activities affected by RFID are carried out before and after the implementation.

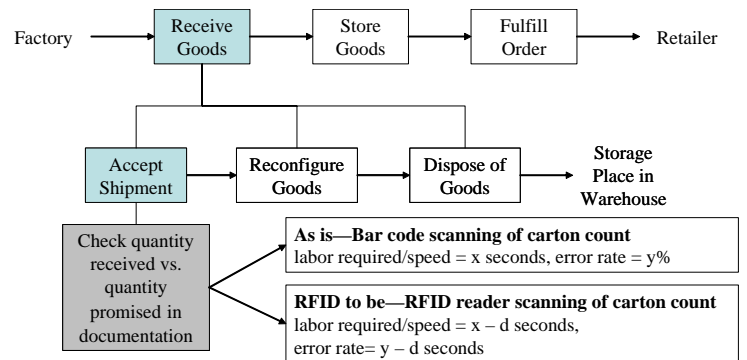


Figure 5: Current vs. RFID-enabled activities – Receiving

4. **Measure benefits and costs by comparing differences in outcomes of pre- vs. post-implementation activities.** This step involves finding instances where the new technology results in changes in the firm's costs or its level of sales. The next step measures benefits by comparing differences in outcomes of pre- vs. the post-implementation activities.

A new technology, or a management intervention of any sort, has the potential to create benefits in two

basic ways: by lowering costs or by increasing sales. RFID has the potential to reduce costs in five ways and increase sales in two:

### Ways that RFID can lower costs

1. **Labor savings resulting from automation.** Warehouse personnel no longer need to scan bar codes on cases; instead, RF antennae detect the presence of ID tags automatically.
2. **Reducing theft or shrinkage (retail).** Theft occurs both within the warehouse and when goods are being shipped to and from the warehouse. Today, errors creep into the counts generated by bar code scanning. As a result, when shortages occur in shipments or in inventory counts, warehouse managers cannot know for certain whether they are the result of theft or human errors. The nearly perfect accuracy enabled by RFID will allow theft to be more readily detected and thus serve as a strong deterrent.
3. **Reduction of disputes with trading partners.** For example, a manufacturer will claim to have sent fifty cases, while the retailer contends that only forty-eight arrived. More accurate RFID-enabled counting can reduce the number of instances when such disagreements occur. For the manufacturer, this means a reduction in double shipments and penalty payments. Fewer disputes also mean less administrative time is needed to research and negotiate customer claims concerning under-shipments. In addition, more accurate counting will reduce over-shipments that favor the customer but go unreported.
4. **Reduction of excess inventory.** The errors that creep into counts today mean manufacturers must carry additional inventory, both in the warehouse and the factory. The more accurate count enabled by RFID will allow the manufacturer to wring out this excess, both in its finished goods inventories at the warehouse and in its raw material and work-in-progress inventories at the factory.
5. **Reduction of spoilage/obsolescence.** Better data on what inventory is on hand can also enable warehouse managers to make sure they are holding the *right* inventory, which can, in turn, reduce write-offs caused by spoilage or obsolescence of products. This is a particular

problem for goods that have short shelf lives, like perishable foods, or rapid product cycles, like consumer electronics. It is also a problem for manufacturers with sales that fluctuate seasonally or that make use of promotions.

### Ways that RFID can increase sales

1. **Reduction of excess inventory.** RFID can increase sales by reducing the number of instances when needed items are out-of-stock. When a retailer places an order that the manufacturer is unable to fill promptly, this has repercussions all the way along the supply chain, resulting in shortages at the retailer's distribution center and eventually its stores. The more accurate inventory count enabled by RFID can significantly reduce sales lost in this way.
2. **Enhancing customer responsiveness.** When a large customer, such as WalMart, mandates RFID, implementing the new technology allows a manufacturer to maintain and potentially improve the existing relationship with that customer. Failing to adopt RFID could result in losing a portion of or even all sales to that customer. RFID adoption by manufacturers has the potential to generate substantial benefits for retailers who also adopt.

### Localized vs. distant benefits

When examining the benefits associated with RFID, we find that some are tied directly to the activities affected by RFID. For example, cost savings associated with automation result from changes that occur in the affected activities themselves, specifically, elimination of the need for workers to scan bar codes. We refer to such benefits as *localized*. Other benefits, by contrast, involve connections between activities directly affected by RFID and activities that occur within other units of the firm or even within outside firms. For example, the more accurate counts that RFID enables by gathering better data during receiving, inventory taking, and order assembly are only one part of what allows spoilage/obsolescence to be reduced. For warehouse managers to make headway against spoilage/obsolescence, they also need real-time data on sales from downstream retail stores and close coordination with their firm's marketing and sales

group, to adjust pricing or promotion policy, and with their factory, to ramp production rates up or down. We thus speak of spoilage/obsolescence reduction as being a *distant* benefit, since it involves not only the activities immediately reshaped by the RFID technology, but other, linked activities in the supply chain.

The distinction between *localized* and *distant* benefits is important because it shapes the extent to which a firm or business unit implementing RFID has direct control over achieving the full benefits of the technology. When most of the benefits are localized, the group implementing the new technology has a high degree of control over whether or not it achieves the benefits. But when many of the benefits are of the distant kind, the implementing group must rely on other business units or supply chain partners to achieve the full potential of RFID.

### Measuring RFID costs

Three types of costs are associated with any RFID implementation:

1. **Enterprise wide:** Middleware and database applications, with associated hardware upgrades, to link to existing IT infrastructure. Costs associated with reengineering enterprise-wide business processes must also be included.
2. **Facility-specific:** Readers, antennae and local computing required to generate data from RFID tags and tie it into the enterprise's IT systems. Costs associated with reengineering facility's business processes must also be included.
3. **Variable:** Cost of RFID tags and equipment/labor needed to affix them.

Costs can be parsed out to each key point in the supply chain by aggregating facility-specific costs for each site and allocating enterprise-wide and variable costs across the sites. Family trees of RFID costs can be constructed in much the same way as family trees of RFID benefits.

Tags will constitute a major portion of the overall costs of any RFID implementation, at least until the unit price of tags drops significantly below today's levels (the cheapest tags are currently priced at approximately 5 cents each). Under the mandates

recently put into place by large retailers, manufacturers are expected to bear this cost. Manufacturers are seeking to spread out the burden, for example, by passing on some of these costs to packaging manufacturers and some to their other suppliers.

### Implications for firms considering RFID investments

The greatest opportunities for manufacturers to create value with RFID - reducing disputes between trading partners wringing out excess inventory, cutting down on out-of-stocks - are the ones that require tightest synchronization of the supply chain. Because achieving these benefits involves complex interaction between disparate units, it is difficult to assess them with traditional measurement methods, which are at their best when they are trained on tightly focused organizational groups, where the firm has full control, and traditional "hard" accounting metrics can be gathered and analyzed closely. Such methods reduce risks by favoring investments where the firm has greater control. But they can also paint managers into a corner by creating the misperception that certain types of benefits are more "real" simply because they are better suited to existing measuring tools.

The truth is that there are a range of potential benefits that can be achieved with RFID technology, each with their attendant uncertainties. The best approach is to examine the entire landscape of possible opportunities, scoping out the magnitude of potential gains, understanding risks, noting instances where supply chain partners' interests are aligned - and where they aren't. This wider view will allow managers to follow implementation paths that capture quickly achievable benefits in areas where their firm has control, thereby generating early wins that can provide staying power to capture the larger, but more difficult to achieve, prizes down the road.

### Advantages of ABPM

A key feature of ABPM is that it focuses on *where* and *how* within a chain of activities a new technology creates value. By estimating the potential size of each type of benefit and by locating where those benefits will be achieved, ABPM allows managers to focus attention during the

implementation on the most important opportunities to create value.

ABPM also allows managers to accumulate knowledge gained in the course of their measurement efforts. Once a firm has assessed the benefits of a technology on a particular group of activities, it can use that prior experience to think systematically about the likely benefits on similar groups of activities. Drawing up family trees of benefits that describe how technologies affect a class of activities can save time by preventing managers from continually re-inventing the wheel.

Our team is currently working at several other field sites. We intend to validate the effectiveness of the ABPM approach and to develop an on-line catalog listing the financial impact of various technologies on particular groups of business activities at those sites. Catalogs like this, which detail the benefits and costs of generated by technologies in different parts of organizations, can also be created inside firms or more broadly, by industry associations or by professional groups that bring together experts in functional areas such as marketing or product development. Catalogs of this sort will be a first step toward development of a next generation of fine-grained, activity level performance measurement and management accounting tools.

**ABOUT THE MIT CENTER FOR EBUSINESS**

Founded in 1999, the Center for eBusiness is the largest research center in the history of the Sloan School. We are supported entirely by corporate sponsors whom we work with closely in directed research projects. The Center has funded more than 45 Faculty and performed more than 60 research projects. Our mission is to join leading companies, leading educators, and some of the best students in the world together in inventing and understanding the business value made possible by digital technologies. Our interactions are a dynamic interchange of ideas, analysis, and reflection intended to solve real problems.

Examples of Current Focused Research Projects:

- Implications of e-Commerce for New Services and Structure of Logistics Systems
- How Do Intangible Assets Affect the Productivity of Computerization Efforts?
- Wireless and Mobile Commerce Opportunities for Payments Services
- Benchmarking Digital Organizations
- The Impact of the Internet on the Future of the Financial Services Industry
- Pricing Products and Services in the High-Tech Industry

The Center for eBusiness has recently entered into Phase II, focusing more explicitly on business value, while at the same time including technologies beyond the Internet (e.g. RFID) in its purview. Our goal, in part, is to reduce that timeline through basic and applied research, engagement with industry sponsors, and the sharing of best practice, and the MIT's credo of combining rigor with relevance is well served.

We are co-located with MIT Sloan's Center for Information Systems Research and the Center for Coordination Science to facilitate collaboration. Our cross-campus collaborations include work with the Media Lab, AutoID Center, Computer Science and AI Lab, and Communications Futures Program.

Please visit our website for more information.



We are organized into five areas of expertise – or Special Interest Groups:

1. **Productivity**
2. **Trust and Customer Advocacy**
3. **Communications Futures**
4. **Interdependence of Security and the Extended Enterprise**
5. **IT Products and Services**

Founding Sponsors

BT  
Cisco Systems  
France Telecom  
General Motors  
Intel  
UPS

Research Sponsors

CSK Corporation  
Suruga Bank  
University of Lecce  
Worldwide Business Research

Member Sponsors

Amazon  
PricewaterhouseCoopers  
Publicis Technology  
SAS

**CONTACT INFORMATION**

MIT Center for eBusiness  
MIT Sloan School of Management  
3 Cambridge Center, NE20-336  
Cambridge, MA 02142  
Telephone: (617) 253-7054  
Facsimile: (617) 452-3231  
<http://ebusiness.mit.edu/>

David Verrill, Executive Director  
Erik Brynjolfsson, Director  
Glen L. Urban, Chairman  
Steve Buckley, Associate Director  
Meredith Sampson, Financial Assistant  
Carlene Doucette, Executive Assistant