Digimarc® Barcode:
A Quantitative Model of Annual Labor Cost Savings and Return on Investment for Retailers

By DIGIMARC CORPORATION

Abstract

The Digimarc Barcode represents a significant evolution in barcode technology – rather than the small black/white set of bars constituting a Universal Product Code (UPC) or European Article Number (EAN) symbol, a Digimarc Barcode contains the same data but distributes it invisibly across the entire package with no special inks, markings, or printing processes. Digimarc Barcodes can coexist on packages with traditional barcodes.

This innovation is a new application of the Company's well-established technology of digital watermarking. It provides significant improvements in scanning the traditional barcode on consumer product packages and labels. The scanning improvements enable significant cashier labor cost savings in high-volume retail environments. This labor cost reduction can be achieved with minimal impact to existing infrastructure and processes of retailers.

This paper describes the Digimarc Barcode, presents a Quantitative Model of the Annual Labor Cost Savings (hereafter, the Model), calculates the total cost of ownership (TCO), and estimates the return on investment (ROI) from adoption of the Digimarc Barcode in high-volume retail market segments. The Model is based on estimates of key factors bearing on the cost of cashier labor associated with scanning goods at checkout within retail markets. These estimates are applied in a straightforward

progression from published Global Retail Sales figures to arrive at estimated Annual Labor Cost Savings for the specified retail segments.

The Model indicates that employing the Digimarc Barcode to augment the traditional barcode is likely to generate significant savings in cashier labor costs, yielding very attractive ROIs. The greatest benefits are expected to accrue to high-volume retailers where checkout time is a critical throttle point. The Model estimates that the total Annual Labor Cost Savings for the group of 120 global high-volume retailers profiled in the Model would be more than $500 million for a single item per minute (IPM) improvement in scanning rate at checkout. This paper presents a hypothetical example to illustrate how the Model works. In the example, a U.S. retailer with $10 billion in annual sales, assuming full deployment and harvesting of benefits, could realize a 5-year ROI over 1200%. The Model described in this paper was used to develop an ROI Calculator for retailers and other interested parties to study the effects on Annual Labor Cost Savings and ROI under various assumptions.

I. Introduction

In the last 40 years, barcodes have become mission-critical enablers of the retail industry, supporting faster checkout times, more accurate pricing, and reliable inventory control. However, the traditional barcode has some obvious limitations. One significant drawback is the requirement that items be correctly positioned prior to scanning, a characteristic that contributes to delays in checkout lines and frustration on the part of both cashiers and customers. Other obvious limitations include the devotion of considerable package real estate to the visually disruptive standard black and white vertical bars, lost revenues from barcode swapping fraud, and difficulty scanning soiled, wrinkled, damaged, or otherwise obscured traditional barcodes. Despite these limitations the barcode has had profound positive effects on the processes and economics of the retail industry.

Digimarc has engineered a significant improvement in the means of identifying and processing consumer packaged goods (CPG) at checkout, which obviates the limitations of traditional barcodes.

The Digimarc Barcode[1,2] was first publicly demonstrated at the National Retail Federation show in January, 2014. It extends Digimarc's well-established and widely deployed automatic identification technology[3] to packaging and labels. The resulting solution materially enhances the encoding and reading of traditional barcode data from packages and labels. The Digimarc Barcode repetitively and imperceptibly encodes the universally employed Global Trade Item Number[4,5] (GTIN) contained in the traditional barcode over the entire surface of packages. Chief among the many benefits of this enhancement is the elimination of the need for cashiers to position packages correctly for scanning at point of sale. The resulting increase in scanning speed creates opportunities for substantial labor cost savings and improvements in customer experience at checkout.

The Model[6] described in this paper provides a tool for retailers to estimate the ROI from labor cost savings resulting from more efficient scanning at checkout due to adoption of the Digimarc Barcode. The Model focuses on the world's largest high-volume retailers, using estimates from publicly-available sources for key factors bearing on the cost for retailers of cashier labor associated with

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[1] "Introduction to the Digimarc® Barcode," January 8, 2014,
http://vimeopro.com/digimarc/barcode/video/82426620

[2] See http://www.digimarc.com/barcode

[3] See http://www.digimarc.com/company

[4] The Global Trade Item Number (GTIN) can contain either a Universal Product Code (UPC) or European Article Number (EAN).

[5] The Digimarc Barcode can accommodate numerous GS1-compliant data structures, including GTIN 8, 12, 13, and 14.

[6] See http://www.digimarc.com/model

scanning goods at checkout. Individual retailers may have costs that differ from those estimated. Publication of the entire Model in spreadsheet format allows for inputs of different assumptions and empirical data when calculating the ROI from adoption of this barcode innovation. There are other potential benefits that are not included in the Model, including improving speed, efficiency, and ease of operation of self-checkout.

TCO for retailers of adopting the Digimarc Barcode includes an initial setup fee for encoding the packages and an annual renewal fee charged by Digimarc. The Digimarc Barcode relies on imperceptible packaging design changes and on Digimarc Barcode-reading software in image-based point-of-sale (POS) scanners. The data encoded into the Digimarc Barcode and transmitted to the POS system are identical to those transmitted in scanning a traditional barcode. Therefore, there are no upstream IT modifications involved. There are no capital expenditures for IT nor are other infrastructure or business process changes required.

The Model does not attempt to estimate costs associated with processes for acceptance of encoded files and printing plate changes. The costs of these activities are assumed to be immaterial to the TCO calculation. The ROI Calculator provides for input of other costs that are proprietary to the retailer to include any costs for which public data is not available.

Normal printing, shipping, and inventory management processes are unaffected. Given the imperceptible nature of the encoding, and the absence of any requirements for special inks, materials, or printing, the Digimarc Barcode-enabled packages can be rolled into normal production seamlessly. For retailers with imaging-based scanners equipped with Digimarc Barcode-reading software, the only process change is to submit digital files of package designs for their private label products to Digimarc Professional Services for encoding. The designs are encoded, tested for readability, and returned to the retailer ready for acceptance testing and silent introduction into the packaging workflow. A printing plate change is required, as would be the case with other package design changes in the normal course of business.

The remainder of this paper includes the following sections:

Section II describes the Digimarc Barcode and how it works.

Section III describes testing to characterize the performance of the Digimarc Barcode.

Section IV discusses Digimarc's motivation for developing the Model and introduces the potential benefits to specified segments of the retail industry.

Section V presents an overview of the Model and the fundamental approach.

Section VI presents the set of assumptions underlying the Model and applies them progressively to determine an estimate for *Annual Labor Cost Savings*.

Section VII describes how retailers can transition smoothly and inexpensively to the Digimarc Barcode.

Section VIII discusses the role of Digimarc Professional Services for encoding reliable and imperceptible Digimarc Barcodes in packaging.

Section IX summarizes and analyzes the potential savings from adoption of the Digimarc Barcode for the top 120 global retailers in identified market segments.

Section X explains calculation of the potential ROI.

Section XI presents an example of ROI calculation for a hypothetical retailer.

Section XII discusses additional benefits of the Digimarc Barcode not quantified or addressed in the Model.
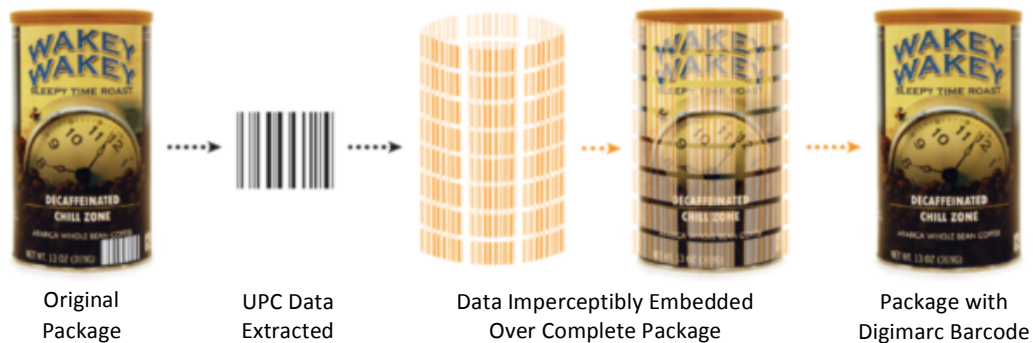
Section XIII summarizes the conclusions of this paper.

Section XIV is a request for feedback from the retail industry to improve and refine the Model.

II. The Digimarc Barcode

The Digimarc Barcode is an application of *digital watermarking*,[7] a signal processing innovation pioneered by Digimarc Corporation that enables human-imperceptible encoding of data into all forms of media. The encoding is undetectable by humans but can be detected by digital devices enabled with Digimarc software. Digimarc and its business partners have delivered mission-critical applications using digital watermarking for automatic identification in numerous fields including counterfeit deterrence for currency, authentication of government-issued IDs, protection of copyrights for movies and commercial images, and audience measurement for television and radio. These applications are well-established and broadly deployed.[8]

The Digimarc Barcode is a digital code applied to packages and variable data labels using Digimarc's proprietary digital watermarking technology.[9] The encoding is applied in the digital image files of the package design as part of the original design process or as a post-design process enhancement and in variable data labels during printing. The Digimarc Barcode encodes GTIN-14 data repetitively over the entire surface of packages and labels, including images, graphics, and text.

| Original Package | UPC Data Extracted | Data Imperceptibly Embedded Over Complete Package | Package with Digimarc Barcode |

Figure 1. Encoding Digimarc Barcodes Imperceptibly into Packaging

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[7] See http://www.digimarc.com/technology/about-digital-watermarking

[8] See http://www.digimarc.com/docs/company-resources/dmrc-company-overview.pdf?sfvrsn=8

[9] See http://www.digimarc.com/patents

The repetitive invisible encoding of the GTIN-14, which can be read independent of the orientation of the package to the scanner, speeds processing by eliminating the need to position the package to expose the traditional barcode to the scanner. The repetitive encoding should virtually eliminate misreads and non-reads associated with traditional barcodes.

The Digimarc Barcode does not require special inks, materials, or printing processes. Once the Digimarc Barcode is incorporated into the design, packages can be produced using existing printing processes without modification. Digimarc Barcodes can coexist on packages with traditional barcodes to ease the transition to Digimarc Barcodes.

Adoption of Digimarc Barcodes requires image-based POS scanners equipped with Digimarc Barcode-reading software. However, the evolution to image-based scanners that is already underway provides an opportunity for retailers to incorporate Digimarc Barcodes into their processes without additional hardware or software investments (**Section VII. Adopting the Digimarc Barcode**).

III. Feasibility Testing and Public Demonstrations

Digimarc's perspective on potential scanning performance improvements is based on limited internal testing with employees and professional checkers as well as on hands-on public demonstrations. The results indicate that using the Digimarc Barcode should significantly increase industry average scanning rates. It is important to note that in-store tests have not yet been performed, so scanning improvements in actual store environments have not been characterized.

The Digimarc Barcode was publicly introduced at the National Retail Federation (NRF) Big Show in January, 2014.[10] At that event, over 150 retail industry members got hands-on experience, scanning a basket of 20 typical CPG items.[11] The participants were encouraged to scan the items as fast as possible. There was no bagging or tender of payment involved. Scanning rates averaged 68.5 IPM with the fastest scanning rate hitting 134 IPM. Only seven of the 157 participants produced results less than 50 percent above industry average scanning rates in the low-twenties. Two Digimarc employees with no prior work experience as professional checkers broke the Guinness Record for scanning and bagging 50 items, shaving 27 seconds off the previous record of 75 seconds.[12]

Tests were conducted with Digimarc employees in conditions comparable to a retail environment. More than 25 employees participated, all of whom lacked cashier training and experience. The employees were timed scanning a basket of 20 items through multiple cycles. Each participant completed 10 cycles relying on traditional barcodes and 10 cycles relying on Digimarc Barcodes. Improvements in scanning rates varied from 13% to 101% and averaged 52%. Variability in scanning rates is expected and consistent with observations from commercial retail environments. As expected, these results are lower than those produced during public demonstrations, which were intended to illustrate theoretical maximum throughput and which sometimes exceeded 100 IPM.

The initial estimate of average scanning rate improvement used within the Model has been set at 33%. This rate is lower than those observed in the

[10] "Digimarc Unveils the Digimarc® Barcode at NRF 2014: Significantly Improves Checkout Scanning Speed While Enabling Unprecedented In-store Mobile Engagement," Press Release, January 13, 2014, http://www.digimarc.com/press-room/press-releases/2014/01/13/digimarc-unveils-the-digimarc-reg-barcode-at-nrf-2014-significantly-improves-checkout-scanning-speed-while-enabling-unprecedented-in-store-mobile-engagement

[11] "Fastest Hands Scanning Digimarc'd Packages at NRF," http://vimeopro.com/digimarc/barcode/video/85198575

[12] See http://vimeopro.com/digimarc/barcode/video/84078592

foregoing demonstrations and tests. The pro forma lower rate used in the Model is intended as a conservative assumption taking into account the fact that the testing was not performed in a commercial retail environment, which may or may not yield the same level of improvement. Retailers and industry analysts can perform sensitivity analyses in the ROI calculator by varying this and other assumptions.

All testing to date has been conducted using the Datalogic Magellan™ 9800i POS scanner[13] enabled with the Digimarc Barcode-reading software. The performance implications with other scanners and handhelds remain to be evaluated.

IV. Purpose of the Model

The Model has been developed to enable retailers to estimate potential Annual Labor Cost Savings, TCO, and ROI from adoption of the Digimarc Barcode. The initial focus is on high-volume retailers in identified segments of the industry and assumes full adoption of the Digimarc Barcode and complete migration to imaging-based POS scanners equipped with Digimarc Barcode-reading software. The Model feeds an ROI Calculator tool that is freely available to the public.

The initial analysis focuses on retailers most likely to realize the greatest labor cost savings from the Digimarc Barcode; i.e., retailers with high transaction volumes and sophisticated workforce optimization systems. The Model was applied to 120[14] of Deloitte's listing of the top 250 largest global retailers[15] in what are assumed to be the segments likely to gain the greatest savings. These Primary and Secondary target markets include:

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[13] See http://www.datalogic.com/eng/products/automatic-data-capture/in-counter-scanner/scales/magellan-9800i-pd-600.html

[14] The other 130 global retailers included in Deloitte's list of the top 250 global retailers include retailers in other market segments not factored into the initial Model but may be analyzed in future models. Global Retail Sales for these retailers in 2012 were $1.4 trillion.

[15] Deloitte Touche Tohmatsu Limited (DTTL) and Stores Media

- Primary Market:
  - Supermarkets (Kroger, Safeway, Woolworths, et al.)
  - Hypermarkets/Supercenters (Walmart, Tesco, Carrefour, Target, et al.)
- Secondary Market:
  - Cash & Carry/Warehouse (Costco, Metro AG, BJ's Wholesale, et al.)
  - Discount (Lidl, Dollar General, Aldi, et al.)
  - Drugstore/Pharmacy (Walgreens, CVS, Rite Aid, et al.)

The Model focuses solely on the measurable hard savings made possible by faster scanning at checkout. Faster checkout coupled with effective workforce optimization systems provides an opportunity for substantial labor cost savings to retailers who adopt the Digimarc Barcode. The Model uses publicly available data to estimate annual savings in cashier labor costs derived from the higher throughput.

The Model is being published for public comment to solicit feedback concerning its logic, assumptions, and sources of data, as well as to vet and improve the value of the ROI Calculator for retailers. In parallel, the Model will be informed by initial prospective customer feedback and findings from market trials and early adoption.

V. Structure of the Model

The Model begins with *Global Retail Sales*[16] by the top 120 global retailers in the initial Primary and Secondary target markets. The Model progressively applies a series of assumptions to derive the *Addressable Scanning Labor Costs* — the portion of labor costs that are specifically impacted by increases in scanning rates enabled by the Digimarc Barcode.

When viewing the estimates generated by the Model, it is important to keep in mind that the pro forma industry estimates are for the top 120 global retailers highlighted in this paper only, not for the entire industry. In addition, there are numerous important assumptions in the Model. For instance, the increase in scanning rates over industry averages is based on internal testing and public demonstrations. Given the lack of actual market data, both the Model and ROI Calculator are being published to allow for sensitivity analyses by allowing users to vary these assumptions.

The Model also assumes that retailers are able to effectively harvest all of the cashier labor savings flowing from adoption of the Digimarc Barcode. It is unlikely that any retailer will realize 100% of the efficiency gains. For instance, many retailers may allocate the benefits of increased efficiency between labor cost savings and increased customer satisfaction. No reliable basis for estimating allocation differences has been identified.

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[16] Deloitte Touche Tohmatsu Limited (DTTL) and Stores Media. The most recent data is for 2012.

The following diagram depicts the Model and illustrates the flow of calculations beginning with Global Retail Sales, showing the method used to calculate potential Annual Labor Cost Savings in relation to those sales. All sources of data used in the assumptions are identified. Intermediate results (orange boxes) are shown along with key assumptions (dark gray boxes) used in the calculations:
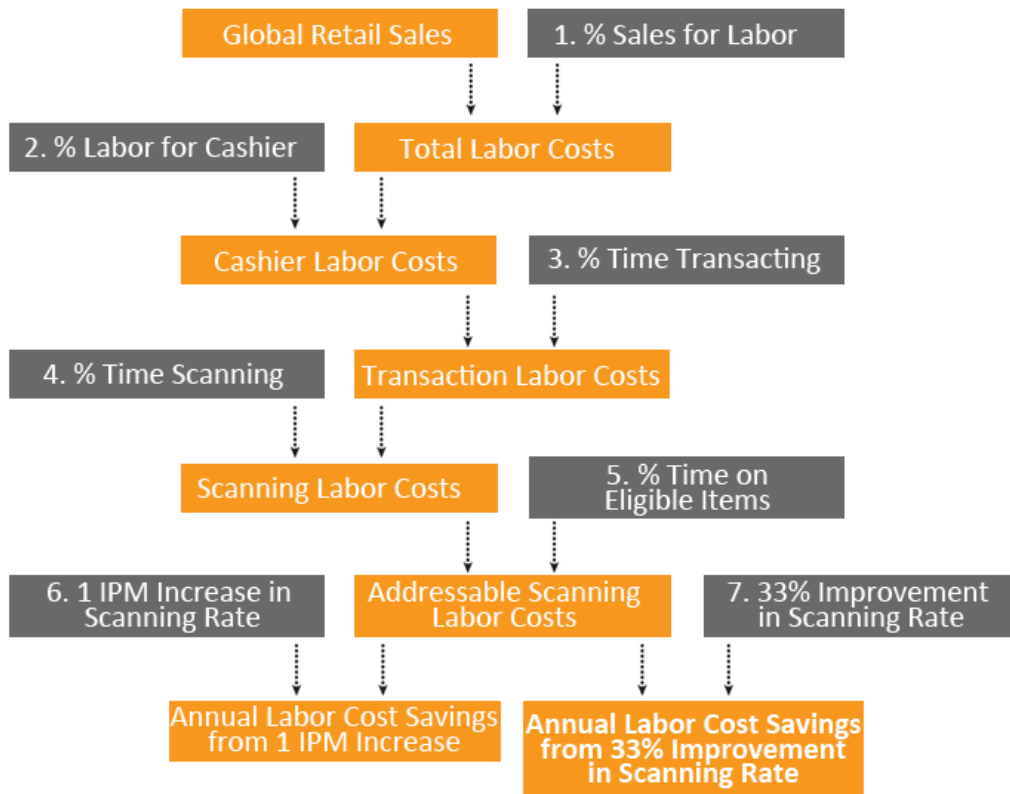
Figure 2. Computing Annual Labor Cost Savings from Global Retail Sales

VI. Estimating Annual Labor Cost Savings

This section presents the progression of calculations in the Model that lead to the estimate of Annual Labor Cost Savings, explaining how each assumption feeds into the Model. Sources and evidence to support the estimates used in the calculations are provided, wherever available.

Assumption 1: Total Labor Costs as Percentage of Global Retail Sales

The Model estimates *Total Labor Costs* as a percentage of Global Retail Sales. Labor costs as a percentage of sales were gathered from the US Census Bureau's 2012 Annual Retail Trade Survey.[17] Total Labor Costs include payroll, fringe benefits and contract labor.

No reliable sources of global variations in labor costs in relation to sales have been identified and the Model does not attempt to estimate these variations. Most of the world's largest retailers included in the Model have sales concentration in the US, Europe, and Japan, where it seems likely that these ratios are similar.

Total Labor Costs as Percentage of Global Retail Sales (USD in millions)			
Segment	% Sales for Labor	Global Retail Sales	Total Labor Costs
Primary Market			
Supermarkets	13%	$1,016,267	$132,115
Hypermarkets/Supercenters	12%	$1,220,541	$146,465
Secondary Market			
Cash & Carry/Warehouse	10%	$206,272	$20,627
Discount	14%	$274,042	$38,366
Drugstore/Pharmacy	11%	$245,097	$26,961

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[17] "Detailed Operating Expenses, Including Accommodation and Food Services", US Census Bureau, http://www2.census.gov/retail/releases/current/arts/bes.xls [Excel] and "Sales (1992-2012)", US Census Bureau, http://www2.census.gov/retail/releases/current/arts/sales.xls [Excel]

The categories of a) grocery stores, b) pharmacies and drug stores, c) discount dept. stores, and d) warehouse clubs and supercenters were used, respectively, to represent our market segments of Supermarkets, Drugstore/Pharmacy, Discount, and Cash & Carry/Warehouse. The market segment Hypermarkets/Supercenters was determined as a consolidation of categories a) & d).

Assumption 2: Cashier Labor Costs as Percentage of Total Labor Costs

Cashier Labor Costs are an identifiable percentage of Total Labor Costs. The Model relies on data from the US Department of Labor Bureau of Labor Statistics.[18] For each segment, the total employment by occupational category was multiplied by the associated annual mean wage to calculate the total labor cost of each category. The total labor cost of the occupational category for cashiers was then divided by the total labor costs of all categories to determine the estimate of percent of total labor costs attributable to cashiers.

No reliable sources of global variations in cashier labor costs to total labor costs have been identified and the Model does not attempt to estimate these variations. Most of the world's largest retailers included in the Model have sales concentration in the US, Europe, and Japan, where it seems likely that these ratios are similar. Additionally, these ratios do not factor in any differences in benefit costs between cashiers and other retail employees as no source data was identified.

Cashier Labor Costs as Percentage of Total Labor Costs (USD in millions)			
Segment	**% Labor for Cashier**	**Total Labor Costs**	**Cashier Labor Costs**
Primary Market			
Supermarkets	27%	$132,115	$35,671
Hypermarkets/Supercenters	24%	$146,465	$35,152
Secondary Market			
Cash & Carry/Warehouse	19%	$20,627	$3,919
Discount	11%	$38,366	$4,220
Drugstore/Pharmacy	9%	$26,961	$2,426

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[18] "Occupational Employment Statistics Survey", May, 2012, US Dept. of Labor Bureau of Labor Statistics, http://www.bls.gov/oes/special.requests/oesm12in4.zip

The categories of a) grocery stores, b) health and personal care stores, c) department stores, and d) other general merchandise stores were used, respectively, to represent our market segments of Supermarkets, Drugstore/Pharmacy, Discount, and Cash & Carry/Warehouse. The market segment Hypermarkets/Supercenters was determined as a consolidation of categories a) & d).

Assumption 3:
Transaction Labor Costs as Percentage of Cashier Labor Costs

Transaction Labor Costs estimates the percentage of Cashier Labor Costs devoted to performing transaction duties — the time that cashiers are processing customer transactions. Most cashiers also have non-transaction processing duties during their shifts, including restocking, helping customers in the aisles, performing back-office tasks, etc. The time spent on these non-transaction duties is excluded from Transaction Labor Costs, as is idle time at the register.

The Model assumes 44% of cashier time is devoted to transactions. The 44% rate is the product of assumptions that cashiers spend 67% of their time at the register and 65% of their time while at the register processing transactions (67% x 65% = 44%). The percentage of time cashiers are at the register is based solely on empirical and anecdotal data (blogs, social forums, and personal observation) as no industry source data was identified. The percentage of time cashiers are processing transactions was based on data from a study[19] of a national supermarket chain, which provided a range from 60% to 69% with an average for all stores of 65%. While the data covers only 2003 through 2006, it is the best available basis for estimation of the percentage of time cashiers are processing transactions.

Transaction Labor Costs as Percentage of Cashier Labor Costs (USD in millions)			
Segment	% Time Transacting	Cashier Labor Costs	Transaction Labor Costs
Primary Market			
Supermarkets	44%	$35,671	$15,695
Hypermarkets/Supercenters	44%	$35,152	$15,467
Secondary Market			
Cash & Carry/Warehouse	44%	$3,919	$1,724
Discount	44%	$4,220	$1,857
Drugstore/Pharmacy	44%	$2,426	$1,068

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[19] Mas, Alexandre, and Enrico Moretti (2009). "Peers at Work," American Economic Review 99(1) 122-145

Assumption 4:
Scanning Labor Costs as Percentage of Transaction Labor Costs

This assumption estimates *Scanning Labor Costs* based on the percentage of *Transaction Time* that cashiers spend scanning items (including produce and other non-barcoded items). Transaction time typically includes scanning, bagging, and tender. The proportion of time spent scanning therefore varies by basket size, bagging responsibilities, and method of payment. The Model derives the estimate for this factor using publicly available data from industry organizations and individual industry sources concerning average transaction times, basket sizes, and scanning rates.

The Model uses 40% for the Primary Market and Cash & Carry/Warehouse stores and 20% for the other segments in the Secondary Market based on the assumption that Discount and Drug/Pharmacy stores generally have smaller basket sizes resulting in a smaller portion of the transaction time spent scanning.

Scanning Labor Costs as Percentage of Transaction Labor Costs (USD in millions)			
Segment	% Time Scanning	Transaction Labor Costs	Scanning Labor Costs
Primary Market			
Supermarkets	40%	$15,695	$6,278
Hypermarkets/Supercenters	40%	$15,467	$6,187
Secondary Market			
Cash & Carry/Warehouse	40%	$1,724	$690
Discount	20%	$1,857	$371
Drugstore/Pharmacy	20%	$1,068	$214

Assumption 5:
Addressable Scanning Labor Costs as Percentage of Scanning Labor Costs

Assumption 5 estimates the Addressable Scanning Labor Costs by multiplying Scanning Labor Costs by the percentage of time spent transacting items which can accept encoding of the Digimarc Barcode (referred to hereinafter as *Eligible Items*). Items not capable of accepting the Digimarc Barcode include produce and other traditionally non-barcoded items, and these are excluded from estimates of Addressable Scanning Labor Costs. Based on 2011 sales data by product category from the Food Marketing Institute,[20] the percentage of time spent transacting produce and other ineligible items is estimated to be 11% in the Model for the Supermarkets segment. This estimate is 5% for the Hypermarkets/Supercenters, Cash & Carry/Warehouse, and Discount segments, reflecting the fact that these segments have a smaller percentage of produce sales than supermarkets. No amount was set for the Drug/Pharmacy segment as they generally do not offer produce. The use of sales data to estimate time spent transacting produce, which generally takes longer than non-produce, may underestimate the real value but no other source data was identified to provide a more reliable estimate.

Addressable Scanning Labor Costs as Percentage of Scanning Labor Costs (USD in millions)			
Segment	% Time on Eligible Items	Scanning Labor Costs	Addressable Scanning Labor Costs
Primary Market			
Supermarkets	89%	$6,278	$5,588
Hypermarkets/Supercenters	95%	$6,187	$5,877
Secondary Market			
Cash & Carry/Warehouse	95%	$690	$655
Discount	95%	$371	$353
Drugstore/Pharmacy	100%	$214	$214

[20] Progressive Grocer's Annual Consumer Expenditures Study (CES): 60th Annual CES, September 15, 2007, pp. 50 - 74; 65th Annual CES, September 2012, pp. 39 -77.

Assumption 6:
Annual Labor Cost Savings from 1 IPM Improvement in Scanning Rate

The Model calculates Annual Labor Cost Savings as a function of the industry standard metric of IPM. For Assumption 6, the Model calculates *Scan Time Reduction* from using the Digimarc Barcode and applies the result to the Addressable Scanning Labor Costs to compute Annual Labor Cost Savings from a 1 IPM improvement in scanning rate.

The Model assumes an industry average scanning rate of 21 IPM for all segments.[21] This assumption indicates that for a 1 IPM improvement in scanning rate, Addressable Scanning Labor Costs can be reduced by up to 5% for all segments (100% - (21 IPM/22 IPM)).

Annual Labor Cost Savings from 1 IPM Improvement in Scanning Rate (USD in millions)			
Segment	**Scan Time Reduction**	**Addressable Scanning Labor Costs**	**Annual Labor Cost Savings**
Primary Market			
Supermarkets	5%	$5,588	$254
Hypermarkets/Supercenters	5%	$5,877	$267
Secondary Market			
Cash & Carry/Warehouse	5%	$655	$30
Discount	5%	$353	$16
Drugstore/Pharmacy	5%	$214	$10
Total			$577

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[21] Multiple Proprietary Sources

Assumption 7:
Annual Labor Cost Savings from 33% Improvement in Scanning Rate

For Assumption 7, the Model calculates Scan Time Reduction and subsequent Annual Labor Cost Savings for an improvement in scanning rate of 33%. This results in a 7 IPM increase using an industry average scanning rate of 21 IPM.[22] Reliable average scanning rate improvements will be determined in market trials and early adoption. Pending such results, the Model assumes a 33% improvement in scanning rate can be achieved based on the initial proofs of feasibility, and other demonstrations and tests described previously (**Section III. Feasibility Testing and Public Demonstrations**). For all segments, the 33% increase in scanning rate from the industry average results in a 25% Scan Time Reduction, which is then applied against Addressable Scanning Labor Costs to calculate Annual Labor Cost Savings (100% - (21 IPM / 28 IPM)).

Annual Labor Cost Savings from 33% Improvement in Scanning Rate (USD in millions)			
Segment	**Scan Time Reduction**	**Addressable Scanning Labor Costs**	**Annual Labor Cost Savings**
Primary Market			
Supermarkets	25%	$5,588	$1,397
Hypermarkets/Supercenters	25%	$5,877	$1,469
Secondary Market			
Cash & Carry/Warehouse	25%	$655	$164
Discount	25%	$353	$88
Drugstore/Pharmacy	25%	$214	$53
Total			$3,172

[22] Multiple Proprietary Sources

VII. Adopting the Digimarc Barcode

The Digimarc Barcode is easy to adopt. The basic workflow of package design and printing is unaffected. Digimarc Professional Services encodes GTIN-14 information in existing designs with minimal involvement from brand management. The only business process change is the submission of print-ready digital files for package designs to Digimarc Professional Services, acceptance testing for the encoded packages, and printing plate changes associated with routine changes to package designs. The process is described in detail below (**Section VIII. The Role of Digimarc Professional Services**). Packages with Digimarc Barcodes are nearly identical in appearance to packages without the codes with no discernable difference to the human eye.

As evidenced by usability tests run at Digimarc using professional cashiers with minimal training in a controlled environment, cashiers quickly began noticing a difference in scanning responsiveness. They observed that Digimarc Barcodes read more quickly and with more freedom of orientation once the Digimarc Barcode-reading software was enabled. When told explicitly that orientation of packages to expose traditional barcodes is no longer necessary, cashiers adapted quickly to take advantage of the Digimarc Barcode and scan packages more rapidly. When the cashiers were given a full explanation of the technology, their understanding and adoption of the technology occurred almost immediately.

The timing of adoption of Digimarc Barcodes depends on two naturally occurring events: the turnover time for inventory and the replacement schedule for POS scanners. Digimarc Barcodes can be added to packaging as inventory is refreshed without regard to the status of scanning infrastructure. The scanning improvement begins with the first package scanned by the first enabled scanner and scales from there.

VIII. The Role of Digimarc Professional Services

The Digimarc Barcode is a feature of the Digimarc Discover platform.[23] Digimarc Discover enhances the Shopper's Journey[24] for mobile-centric shoppers by providing automatic identification of all brands via the cameras and microphones of smartphones and tablets. Encoding most media to enhance the Shopper's Journey can be completed through self-service by brand owners via Digimarc's Online Services Portal[25] or using Adobe® Photoshop® plug-ins[26] provided by the Company.

Packaging is more complicated to encode than other media. The variety of inks, materials, surface topologies, and printing processes necessitates considerable expertise. Digimarc Professional Services has such expertise, with more than fifteen years of detailed work in the encoding of printed media involving a wide variety of designs, materials, and printing processes. Use of Digimarc Professional Services will ensure high quality encoding to deliver the intended benefits throughout the lifecycle of the products. Over time, the Company expects to provide encoding tools and training to certified third parties to build a network of qualified service providers.

Digimarc Professional Services provides these encoding and quality validation services during the pre-press phase of package production for both new and existing package designs. For new packages, Digimarc can provide the package owner's design team with detailed specifications and best practice examples for reference during package design. For existing package designs, Digimarc Professional Services will work with the brand's design team to acquire final

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[23] See http://www.digimarc.com/discover

[24] See http://www.digimarc.com/shoppersjourney

[25] See http://www.digimarc.com/osp

[26] See http://www.digimarc.com/docs/default-source/discover-resources/dmrc-digimarcdiscover-osp-overview.pdf?sfvrsn=6

print-ready files of the packaging artwork. These files typically come from the printer or pre-press shop involved in producing the package. Print-ready files include the color-corrected images and accurate spot colors that enable Digimarc Professional Services to encode Digimarc Barcodes effectively. These files are generally created in applications such as Adobe® Illustrator® and InDesign with all Photoshop links included.

For both new and existing designs, Digimarc Professional Services verifies robustness and accuracy of encoded GTIN-14 data. Digimarc Professional Services encodes the Digimarc Barcode into the package design to maximize readability while preserving the integrity of the design. A proof of the encoded file is generated and printed to enable an extensive suite of tests using robotics, commercially available POS imaging scanners, and mobile devices enabled with Digimarc Barcode-reading software. Once the package has been approved and has successfully passed validation testing, Digimarc certifies the package as reliable and ready for printing and distribution into the supply chain.

Encoding a package can require up to 10 hours of Professional Services time depending on the design complexity and substrate material of the package. The initial setup fee for encoding is estimated at $300 per Digimarc Barcode. Redesigns of a package will require an additional fee. There is an annual renewal fee for each Digimarc Barcode of $50. Both the initial setup fee and annual renewal fee are subject to change. These projected costs are reflected in the ROI estimations below (**Section X. Return on Investment**). These are the only known third-party costs of adoption of the Digimarc Barcode. The business process overhead is generally limited to provision of files, acceptance testing, and plate changes. Given the early stage in the adoption cycle, we do not know whether professional scanner vendors will seek additional fees for Digimarc-enabled scanners.

IX. Detailed Analysis of Potential Annual Labor Cost Savings

The Model indicates billions of dollars in potential Annual Labor Cost Savings for the top 120 global retailers in the initial Primary and Secondary target markets, which is only a subset of the addressable market. Global retail sales are estimated to be $10 trillion, approximately three[27] times the US market. The estimates for savings in the Model are specific to approximately 30 percent of global retail sales.

Application of the assumptions discussed above (**Section VI. Estimating Annual Labor Cost Savings**) yields significant potential Annual Labor Cost Savings and *Margin Improvements*:

Segment	Global Retail Sales	Annual Labor Cost Savings from 33% Increase in Scanning Rate	Margin Improvement from 33% Increase in Scanning Rate
Estimated Annual Labor Cost Savings and Margin Improvement from 33% Increase in Scanning Rate (USD in millions)			
Primary Market			
Supermarkets	$1,016,267	$1,397	0.14%
Hypermarkets/Supercenters	$1,220,541	$1,469	0.12%
Secondary Market			
Cash & Carry/Warehouse	$206,272	$164	0.08%
Discount	$274,042	$88	0.03%
Drugstore/Pharmacy	$245,097	$53	0.02%
Total	$2,962,219	$3,172	0.11%

The Model's estimate of potential Annual Labor Cost Savings gained from a one IPM improvement in scanning rate has been tested against ad hoc data provided by four of the top 50 US retailers. These retailers have access to

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[27] US retail sales represented $1 trillion of the $3 trillion in Global Retail Sales in 2012 used within the Model. Data from Deloitte Touche Tohmatsu Limited (DTTL) and Stores Media.

operating data that Digimarc does not. Their estimates are useful indicators of realistic savings expectations generated by increased throughput. The sales-weighted average Annual Labor Cost Savings for a one IPM improvement in scanning rate for the group was $25 million.

Estimated Cashier Labor Costs for each of the four retailers who provided data were input into the Model. These costs varied from retailer to retailer and from industry averages, reflecting individual characteristics of their business models and workforces. Annual Labor Cost Savings for each retailer were computed in the Model and compared to the relevant data provided. The projected Annual Labor Cost Savings for the four retailers ranged from 80% to 110% of average results in the Model, with a sales-weighted average of 95%. Variations in savings among retailers are expected.

X. Return on Investment

The primary objective of the Model is to assist retailers in calculating ROI when making procurement decisions concerning the Digimarc Barcode for packaging and labels. The TCO of the Digimarc Barcode includes a setup fee for encoding by Digimarc Professional Services plus an annual renewal fee, marginal costs of delivery and acceptance testing of package designs, printing plate change fees, and possible upcharges by scanner vendors.[28]

The Model provides an indication of the potential value. This initial version of the Model is built on limited data for certain assumptions, and has not yet been vetted by public comment, studied in detail by retailers employing proprietary data, or validated through market trials. Therefore, the assumptions used in calculating ROI are tentative. The ROI Calculator does not include any costs for Digimarc Barcode-reading software in image-based scanners, as it has not yet

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[28] As noted above, given that the Digimarc Barcode was recently introduced, pricing for Digimarc Professional Services is not yet firmly established. The setup fee and renewal fees may be modified from time to time as the value of the Digimarc Barcode is better established.

been established whether there will be any upcharge and, if so, how much. Digimarc is not directly charging retailers a separate software license fee. As to the costs of the scanners themselves, the general transition of the industry to imaging scanners is already underway, with the cost of such scanners justified by other features and benefits.

The ROI Calculator allows retailers to input their own assumptions (revenues, labor costs, transaction data, etc.) to estimate Annual Labor Cost Savings and ROI from implementing the Digimarc Barcode. The default settings within the ROI Calculator reflect the estimates outlined above (**Section VI. Estimating Annual Labor Cost Savings**).

There are two scenarios in the ROI Calculator: (1) all packages are encoded and (2) only private label packages are encoded. Retailers control their private label brands and can generate considerable savings from the encoding of these products alone. The encoding of national brands will be influenced by encouragement from retailers and demonstrations of value to those brands of benefits other than speed of scanning. There are many benefits other than faster scanning (**Section XII. Benefits Not Quantified in the Model**), but the financial implications of such benefits are not included in the Model. Encoding of private brands by retailers to create labor cost savings opportunities will lay the foundation for proofs of the value of these benefits, which can be used in advocacy by Digimarc and retailers for adoption of the Digimarc Barcode by national brands.

The preliminary TCO assumes an initial setup fee of $300 and an annual renewal fee of $50 for each Digimarc Barcoded package. These prices subject to change as the value proposition characterized in the Model becomes better established.

The ROI Calculator calculates ROI over five- and ten-year periods, reflecting assumptions about average CPG product lifecycles. The ROI Calculator provides other metrics including annual savings per store and annual savings per stock-keeping-unit (SKU).

XI. Hypothetical Example

Retailer ABC operates a chain of 250 supermarkets across the United States with annual sales of $10 billion of which $2.5 billion come from its private label brand. Retailer ABC offers its customers the same 40,000 distinct SKUs in each store of which 25% or 10,000 SKUs are private label brands. The retailer designs the packaging for the private label products. Retailer ABC has installed Digimarc-enabled Datalogic Magellan™ 9800i scanners and effective workforce optimization systems in all of its stores.

Retailer ABC's in-store inventory replenishment has resulted in all private label products on the shelf being encoded with the Digimarc Barcode at the beginning of year one. The retailer "flips the switch" January 1. The Year One TCO includes a Professional Services charge of $300 for encoding (which has been accrued from inception of the relationship) and an annual renewal fee of $50, both on a per Digimarc Barcoded package basis.[29] The cumulative year one TCO is $3.0 million and the ongoing TCO is $0.5 million per year. Assuming full harvesting of the benefits of faster scanning rates by reducing labor costs through effective workforce optimization systems, the ROI Calculator indicates that, even without any national brand adoption, Retailer ABC could save nearly $4 million each year. Retailer ABC could recover its first-year investment within roughly 9 months and realize an ROI of nearly 30% in the first year. After 5 years the total return could exceed $14 million with an ROI of over 275%. After 10 years the total return could exceed $30 million with an ROI over 400%.

Adoption by national brands would dramatically increase the ROI. If the Digimarc Barcode were deployed in all 40,000 SKUs, the TCO would not change for Retailer ABC as the costs of the Digimarc Barcode for national brands would likely be borne by those brands. The projected savings by Retailer ABC would increase from $4 million to nearly $14 million per year. With full coverage of all

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[29] These prices are estimates and subject to change.

eligible items, the projected five year total return would exceed $60 million with an ROI of over 1200%. After 10 years the total return would reach $130 million with an ROI over 1700%.

Retailer ABC would save on an annual basis $55,000 per store if all SKUs were encoded and $15,000 per store if only its private label brands were encoded, with each Digimarc Barcode enabled product contributing $300 to $400.

This hypothetical example is reflected within the ROI Calculator as part of the Model. Retailers are encouraged to inform the assumptions with proprietary operational data and to contact Digimarc to discuss potential implications.

XII.   Benefits Not Quantified in the Model

This white paper focuses on the quantifiable labor cost savings and related ROI to be realized from faster throughput at POS resulting from adoption of the Digimarc Barcode. This section briefly identifies some of the other benefits expected to result from use of the Digimarc Barcode.[30] Some of these benefits could potentially lead to measurable cost savings or increased sales and margins. Financial modeling is being deferred pending indicative data from field trials and early adopters of the Digimarc Barcode. Potential benefits not included in the Model:

- Increased customer satisfaction from shorter checkout lines
- Fewer misreads, non-reads, and other processing errors associated with traditional barcodes
- Reduction in lost revenues from barcode swapping fraud
- Faster and more intuitive self-checkout process for customers, resulting in increased usage and customer satisfaction

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[30] For more extensive discussion and examples of these benefits, see
http://www.digimarc.com/retail

- Repurposing of recovered checkout lane floor space into merchandising
- Increased checker satisfaction from ease of scanning packages and labels, including fewer misreads and non-reads
- Enhanced customer engagement allowing easy and reliable recognition of products using smartphones
- Reduced logistical costs with faster and more accurate inventory tracking capabilities

XIII. Conclusion

The Model described in this paper indicates that adopting the Digimarc Barcode may provide significant hard cost savings to the retail industry, potentially saving high-volume retailers billions of dollars annually through the reduction of cashier labor costs alone. Because the Digimarc Barcode can coexist with traditional barcodes, the retail industry can transition smoothly to using the Digimarc barcode with minimal operational impact. The expected upgrading of existing scanners to image-based scanners provides an opportunity for retailers to incorporate Digimarc Barcodes into their processes without additional IT investments. The Model's ROI Calculator demonstrates that such retailers can recoup their investments in adopting the Digimarc Barcode in less than one year. The Model allows readers to enter their own values for its underlying assumptions to obtain customized cost-saving and ROI estimates for different retailers or retail scenarios.

This initial version of the Model focuses on 120 global retailers in the Primary and Secondary target markets. It projects potential Annual Labor Cost Savings from the Digimarc Barcode, once fully deployed, and assumes that the benefits are effectively harvested. These retailers account for approximately 30 percent of global retail sales. No attempt is made to extrapolate these estimates to the remainder of the global retail industry. Similarly, there are no estimates in the Model of soft savings and other likely benefits of the Digimarc Barcode. These

potential savings and benefits are expected to be the subjects of subsequent in-depth studies.

XIV. Request for Feedback

Digimarc welcomes feedback aimed at improving the Model and key assumptions that it relies upon. The Model contains many assumptions based on limited publicly-available data. Improvements to the Model and associated ROI Calculator are expected to play an important role in facilitating procurement decisions of retailers and informing resource allocations of Digimarc and its business partners and of retailers and their suppliers. Please provide comments, criticisms, alternative views, sources of additional data, etc. via the following channels:

- **Digimarc Site:** http://digimarc.com/model
  An online forum is available to post any and all feedback at the bottom of the page.

- **Twitter:** http://twitter.com/DigimarcCorp
  Provide your feedback via Twitter by messaging @DigimarcCorp or using the #DigimarcBarcode hashtag.

- **Email:** Barcode@digimarc.com

Glossary

- **Addressable Scanning Labor Costs**: the portion of Scanning Labor Costs dedicated to scanning consumer packaged goods marked with traditional barcodes and therefore potentially impacted by adoption of the Digimarc Barcode

- **Annual Labor Cost Savings**: the estimated annual labor cost savings due to improvement in cashiers' scanning rates resulting from adoption of the Digimarc Barcode

- **Average IPM Scanned**: an estimate of the average Items Per Minute scanned by a professional cashier

- **Cashier Labor Costs**: the portion of Total Labor Costs dedicated to cashiers, calculated as a percentage of Total Labor Costs

- **Digimarc Barcode**: a digital code applied to consumer packaged goods using Digimarc's proprietary digital watermarking technology. The Digimarc Barcode is imperceptible to humans but detectable by POS image-based scanners equipped with Digimarc Barcode-reading software.

- **Digital watermark**: a digital code that can be applied to any digital media (audio, images, packaging, etc.) for identification. Digital watermarks are imperceptible to humans but detectable by a wide range of devices (computers, scanners, smartphones, tablets, etc.) equipped with Digimarc software.

- **Eligible Items**: items that can be encoded with the Digimarc Barcode — generally all traditionally barcoded items including fresh in-store item labels. It does not include produce.

- **Estimated IPM Increase**: the estimated increase in scanning rate resulting from adoption of the Digimarc Barcode by retailers. The estimate is based on Digimarc's controlled in-house testing as well as on public demonstrations.

- **Global Retail Sales**: the total global sales of the selected retail market segments

- **Items Per Minute (IPM)**: the unit of measurement of the rate of scanning consumer packaged goods encoded with traditional barcodes or Digimarc Barcodes

- **Margin Improvement**: the percentage of Global Retail Sales represented by the Annual Labor Cost Savings from adoption of Digimarc Barcode.

- **Scan Time Reduction**: the percentage reduction in scanning time resulting from scanning items encoded with the Digimarc Barcode compared to the time to scan the same number of items encoded with traditional barcodes

- **Scanning Labor Costs**: the portion of Transaction Labor Costs dedicated to scanning all items including produce and other items not encoded with traditional barcodes or Digimarc Barcodes

- **Scanning Rate**: speed at which a professional cashier scans encoded items, expressed as IPM

- **Total Labor Costs**: the total labor costs for retailers in the selected market segments. This is calculated as a percentage of Global Retail Sales.

- **Transaction Labor Costs**: the portion of Cashier Labor Costs dedicated to processing customer transactions. This excludes time that cashiers spend on other tasks such as restocking as well as idle time at the register.

- **Transaction Time**: the time spent by cashiers processing customer transactions, which typically includes scanning, bagging, and tender activities.