WHITE PAPER

MULTI-MODAL DATA COLLECTION

▶ *Driving New Levels of Warehouse Efficiencies*

SUPPLY**CHAIN**
S E R V I C E S

DELIVERING RELIABLE DATA COLLECTION SOLUTIONS

Leveraging technologies to drive automation in warehouse and distribution center (DC) environments has been a consistent theme over the past couple of decades. Driven by the need for more efficient material handling and overall supply chain process solutions such as bar code data collection, RFID, mobile computers, wireless networks powered by warehouse management software have combined to support more seamless warehouse operations.

MEASURING WAREHOUSE EFFICIENCIES TODAY

While the demise of warehousing has been predicted on numerous occasions – largely as a consequence of practices such as just in time (JIT), direct store delivery (DSD) and quick response – the reality is that warehouses continue to play a pivotal role in today's supply chain processes. What is happening, however, is that warehouses are evolving from glorified storage centers into a new breed of technically sophisticated warehouse and DC service providers.

The impact of warehouses and DCs on making supply chains more efficient and effective is considerable. Key among these are consolidating shipments to customers, reducing transportation costs and providing a broad range of value added services such as packaging, branding, labeling and reverse logistics. For warehouses and DCs it is ultimately about their impact on enterprise optimization strategies and leveraging product position/location and delivery as a key competitive advantage. Factoring into these strategies are a number of complex variables - for example optimizing the cost tradeoffs between transportation, labor and capital equipment not to mention the impact of the type of product that is being stored and distributed.

At the end of the day the primary role of the warehouse and DC is providing the right product at the right time to the right customer all at a competitive cost. Given the nature of warehouse operations there are a multitude of ways to measure performance. However, in our experience the most critical include:

- Perfect order: A compound measure of picking accuracy, on-time delivery rate, shipping without damage and order entry accuracy
- Fill rate: Lines shipped vs. ordered
- Ship to promise: Timeliness of order filling
- Customer retention: Activity taken to reduce customer defections
- Warehouse capacity utilization: Effective use of available storage and handling capacity

While organizations are much more attuned to measuring and tracking key warehouse and DC performance metrics, many do not measure these variables on a consistent basis. Outside of on-time shipment and order filling accuracy – tracked by approximately 8 in 10 organizations – many organizations are not actively tracking other key metrics. What makes this especially critical is that the gap between leaders and laggards – in terms of warehouse and DC operational performance – illustrates significant opportunity for improvement. The most acute performance gaps are in areas such as lost sales (percent of SKU stock-outs), dock to stock cycle time, back-orders as a performance of total lines and, increasingly, labor turnover.

Fundamentally, data and information is the critical ingredient for any successful warehouse operation. Making a spot decision on labor and space requirements to meet seasonal demand or longer term capacity requirements decisions are all made possible by access to accurate information in real time. The use of information technologies – from mobile and wireless data collection systems to underlying warehouse management solutions (WMS)– are key to developing accurate and actionable information and are mission critical to optimizing warehouse performance.

WAREHOUSE AUTOMATION TECHNOLOGIES: A PRIMER

Warehouse automation solutions have evolved considerably over the past 20+ years from the days of Logisticon developing highly customized software solutions that managed materials and labor through the use of barcode scanning technology and proprietary wireless infrastructure. Fast forward twenty years and the warehouse management software space has evolved into a $1billion market supported by a mix of best of breed software players, ERP vendors and niche providers. In addition, in 2011 spend on rugged handheld devices and rugged forklift mounted computers – prevalent in any warehouse today – exceeded $900 million while investments in AIDC solutions and wireless infrastructure represented an additional several $100 million. VDC estimates that rugged mobile computing revenue growth in the warehouse/DC segment will average 7-9% over the next five years.

Key solutions supporting warehouse automation solutions spans data collection technologies and wireless networking solutions to key warehouse management system software applications and databases – fundamentally the brains supporting warehouse operations. Some of the key trends impacting each of these solutions are summarized below:

Mobile Computers:

- In most warehouses today, warehouse workers are using and interfacing with some type of mobile computer. These devices are typically handheld or wearable devices or are mounted onto forklift trucks.
- Mobile computers need to be designed to withstand the harsh warehouse operating environments. Rugged capabilities such as drop specifications, dust and water ingress protection (IP) and, in the case of forklift mounted computers, the ability to withstand vibration is critical. Unique warehouse environments – such as cold storage – may require specialized equipment that can withstand extreme temperatures as low as minus 5 degrees (F) and have internal heating elements to counter frosting and condensation.
- In addition to supporting a variety of automatic data capture solutions; many of these mobile computers have full keyboards for data entry. However, in order to reduce less efficient key stroking, warehouse applications are migrating to more touch-centric interfaces. This in turn, is driving demand for larger displays especially as gloved hand operation is a critical requirement in these environments.

Mobile Software:

- Mobile device management (MDM) software that supports centralized and remote management of mobile devices, including software provisioning, remote troubleshooting, etc. is a growing requirement for mobile warehouse deployments of all sizes and, according to VDC's research, reduces the per user annual support costs by as much as $200.

Average Annual Per Mobile Device Support Costs (in USD)

With MDM	~$35
Without MDM	~$263
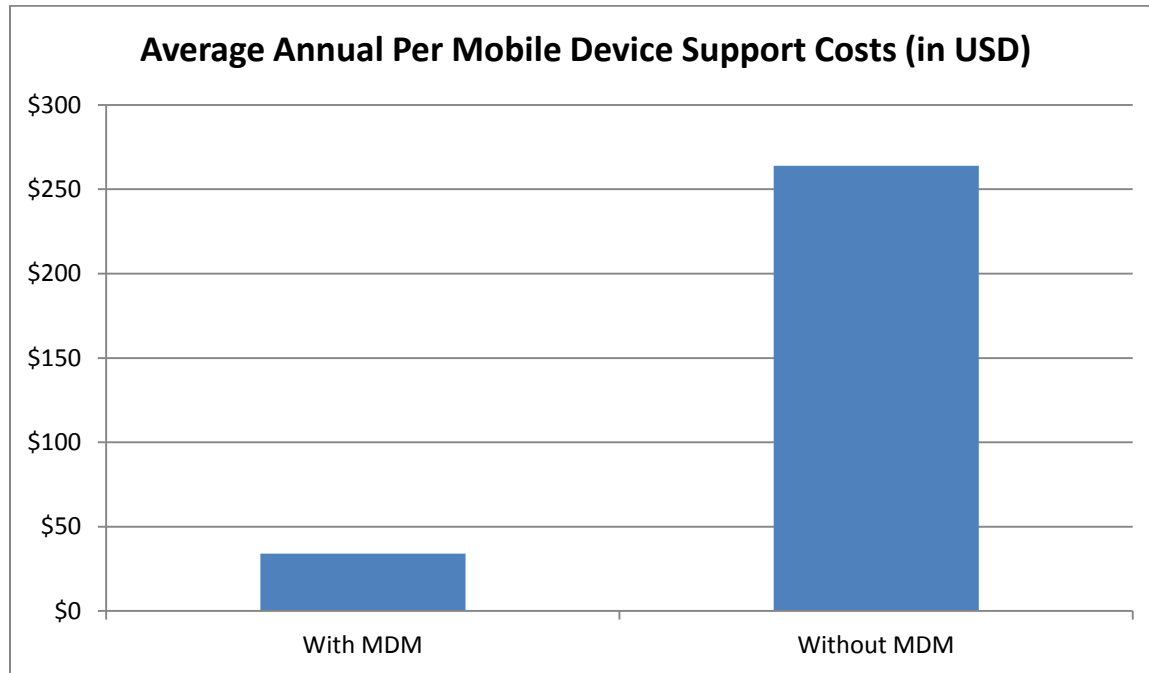
- For ruggedized devices used in warehouse environments Windows Embedded CE and Embedded Handheld are the dominant OS platforms with the overwhelming majority of these are deployed as terminal emulation (TE) clients. Next generation more user friendly/consumer mobile OS are unlikely to impact the conservative warehouse market anytime soon.

Automatic Identification and Data Collection:

- Automatic data capture technologies are critical to ensure and enable not only the material handling efficiencies required but also to maintain inventory accuracy. A multitude of data collection technologies are being leveraged – from traditional barcode scanners to voice capture solutions and RFID.
- Barcode scanning is the most pervasive AIDC technology used in warehouses today. A critical requirement unique to warehouses has been long range scanning (of up to 45 feet using reflective labels). Traditionally the domain of laser scanners, barcode imagers are beginning to enter the warehouse as 2D barcodes become more common and as area imaging technology can support long range decoding applications. In addition, performance of imagers for outdoor applications such as yards where operators may be exposed to direct sunlight is superior to laser technology.

- RFID is increasingly being evaluating and deployed for warehouse applications. RFID can be used for many common warehouse and DC inventory management operations, including receiving, putaway, picking and shipping procedures. RFID has high return on investment potential when applications take advantage of its reading characteristic to overcome previous limitations or to enable new business processes.
- Wearable computers that leverage voice technology using speech recognition and speech synthesis to allow workers to communicate with the Warehouse Management System (WMS) are increasingly used in high-volume warehouses. Solutions include a wireless, wearable computer with a headset and microphone to receive instructions by voice, and verbally confirm their actions back to the system. The most common application is order picking where improved accuracy and productivity offer a fast payback. Additional applications include goods receiving, pallet put-away and let-down, and stock checking.

Printing and Labeling Solutions:

- Label printers are widely deployed throughout warehouses to produce a variety of shipping labels, pallet and case labels, etc. Most of these printers are stationary and are located at the end of packaging lines – or are in-line printers that directly code onto items.
- One way to increase productivity is having the ability to print and apply labels right at the point of activity-whether that be labeling a shelf when boxes are moved, a pallet being shipped, an order being picked, or inventory being received. Consequently many warehouses are deploying mobile printers.

Wireless Infrastructure:

- Critical to any warehouse automation solution is a robust wireless communications infrastructure. Depending on the layout and size of the warehouse and coverage requirements inside and outside of the warehouse a variety of wireless solutions are deployed.
- The most common wireless solutions are standard WiFi 802.11 networks. However, with tall ceilings and steel racking and shelving, wireless interference can be a major challenge for poorly designed networks. Applying redundancy and mesh networking to wireless system design, in addition to leveraging industrial grade access points with high gain antennas, are critical to avoiding coverage and interference issues.
- In specialized environments – such as large yards and port facilities – the use of private licensed wireless networks such as narrow technology is deployed. These solutions are deployed to overcome the coverage challenges for WiFi in such large areas in addition to providing technical benefits and standards protection.

Enterprise Software Platforms: ERP, WMS and TMS

- Enterprise software platforms, such as ERP, WMS and TMS represent the critical backbone of any supply chain and warehouse operation. Each serves a specific purpose; however, many functions are beginning to blend.

- In its simplest form, the WMS can track products during the production process and act as an interpreter and message buffer between existing ERP and WMS systems. Warehouse Management is not just managing within the boundaries of a warehouse today; it is much wider and goes beyond the physical boundaries. Inventory management, inventory planning, cost management, IT applications & communication technology are all related to warehouse management.
- Warehouse management systems are continuously becoming more intelligent, driven by the need to optimally manage larger and more complex operations. One area where this has manifested itself is in the integration of the WMS with other platforms such as transportation management.
- A transportation management system (TMS) usually "sits" between an ERP or legacy order processing and a warehouse/distribution module. A typical scenario would include both inbound (procurement) and outbound (shipping) orders to be evaluated by the TMS Planning Module offering the user various suggested routing solutions. Links back to ERP systems (after orders turned into optimal shipments), and sometimes secondarily to WMS programs also integrated to ERP are also common.
- In addition to tighter TMS integration, labor management integration with the WMS represents another critical development and has the effect of enabling the WMS to make better decisions. Evidence of this is in the sophistication of WMS systems being able to dispatch orders to specific warehouse zones to better balance work across picking areas – or, for example, the WMS may hold the release of an order to a pick zone if that area is already busy with vehicle activity.

Although warehouse technologies are maturing and changing, efficient warehouse management can deliver significant operational and competitive benefits. In the past this was a "one size fits all" solution for warehouse automation. Today, advances in various modalities of data capture present alternative solutions that are appropriate to specific process applications. It is not simply the data capture technology that leads to increased efficiencies but the expansion to multiple platforms of automation which enhance these benefits by using the right technology for the job.

IMPACT OF APPLICATION OF MULTI-MODAL SOLUTIONS ON WAREHOUSE OPERATIONS

The transformation of the warehouse function is currently underway. One of the most critical developments has been the migration of the warehouse from purely a cost-center to one of potential value creation. Forward thinking organizations are looking at how they can not only modify and optimize workflows and processes within the warehouse but also how this function is integrated within the organization. What is fundamental is the recognition that the quality of receiving, storing and delivering product can directly impact production, marketing and sales. In today's progressive automated warehouse environments, these workflows work in a smooth and uninterrupted fashion.

 One of the most significant recent trends we have been tracking that is enabling even greater operational efficiencies is in the application of multiple (i.e., multi-modal), diverse data collection, wireless and automation technologies in the warehouse and DC. More specifically, we are observing progressive organizations gain value from more specifically aligning automation technologies – such as

voice technologies, RFID, 2D imaging and/or traditional linear barcode scanning – with unique warehouse workflows. In other words the workflows – from shipping and receiving, to staging and kitting and cross docking – are closely aligned, or optimized, with the capabilities of a particular data collection and automation technology. The operational benefits realized are creating new levels of warehouse efficiencies and overall performance.
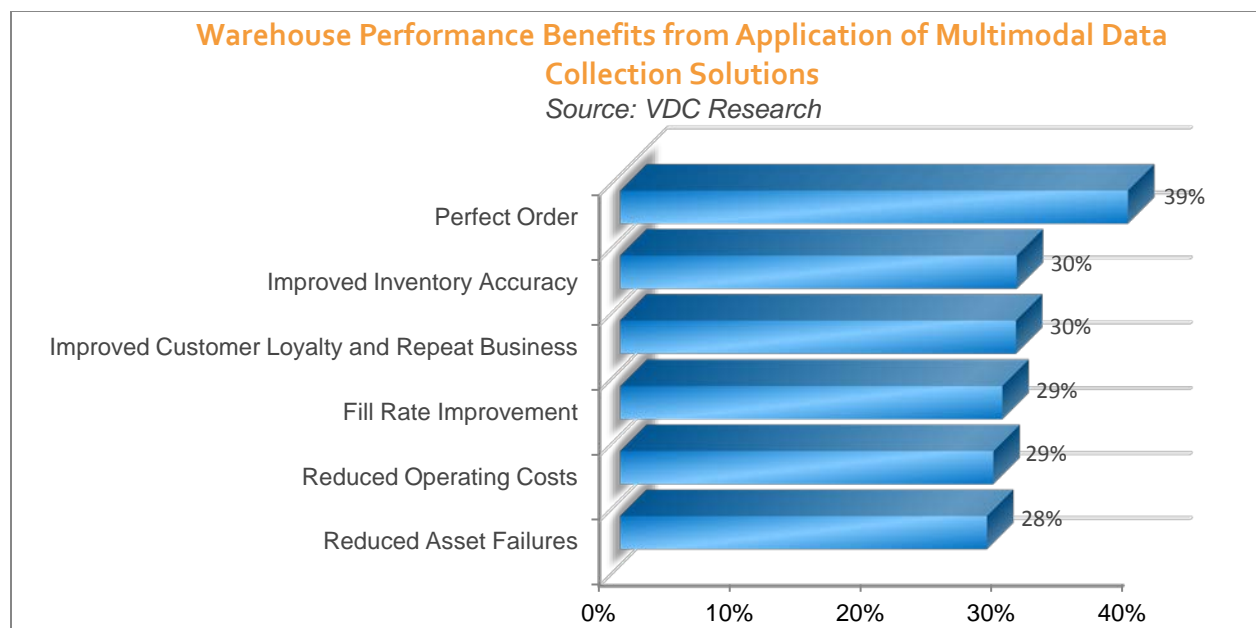
Some of the greatest inefficiencies incurred in warehouse and DC operations are the result of applying the wrong technology to address a specific workflow or application. For example, the use of laser scanners in environments exposed to bright sunlight, or the use of a gun scanner for high volume picking applications or the use of linear barcodes to identify returnable assets all represent real life deployment scenarios and are examples of technologies not properly aligned with the specific workflows they are intending to support. Consider the following real world warehouse application scenarios and technology solutions:

Application Scenario and Issue	Key Solution
Long range scanning requirement with limited space to apply barcodes	• Initial solution was to apply a small/dense 1D barcode on warehouse rack which could not be read at long distances. This required the forklift operator to leave the forklift to scan resulting in poor performance metrics. • Final solution was to use real estate efficient 2D barcodes and a 2D long range imager resulting in substantial improvements in picking efficiency.
Scanning barcodes in direct sunlight in the yard to support outdoor inventory	• The initial solution was to use the long range laser scanners, used inside the warehouse, for outdoor applications. However, in bright sunlight laser scanners are notoriously ineffective resulting in unacceptable decode rates. • Final solution was to deploy long range imagers which experience no performance degradation in direct sunlight conditions.
Picking performance and accuracy in auto parts distributor warehouse.	• The initial solution used handheld barcode scanners to collect necessary picking information. The issue was that the use of the gun scanner interfered with the operators picking performance that required both hands. • The final solution was a wearable voice technology solution that uses speech recognition and speech synthesis to allow operators to communicate with the WMS. Picking performance increased by 40% while accuracy increased by 21%.

Utilization and asset management performance issues with reusable assets such as pallets and drums	• Leading retailer with over 5 million reusable assets (pallets, drums, containers, etc.) was using linear barcodes to identify and track these returnable containers. Severe limitations to track these assets and associate them with specific customer shipments using static barcodes. • Final solution was to apply RFID tags to the reusable assets that were encoded with unique customer identifiers. This enabled the retailer to track their movements and associate them with specific customer shipments thus building an accurate information foundation to recover more of their assets and manage them more efficiently.

Relying on a multi-modal approach, the proper application and alignment of warehouse automation technologies is having real impacts on operational performance. In fact, where we are witnessing the most significant operational improvements is within warehouses that are taking a multi-modal approach to their warehouse solutions. The most critical metric expressing these benefits is in improvements to perfect order performance. The metric is a compound calculation that measures picking accuracy, on-time delivery rate, shipping without damage and order entry accuracy. On average, we are seeing improvements in this metric of approximately 39% as organizations optimize their warehouse and distribution center workflows with the appropriate technology. The compound impact of scenarios described above is substantial. Beyond perfect order, the realization of improvements in other key metrics such as inventory accuracy and customer loyalty and retention are substantial. These benefits are translating not only into reduced operating costs but are also enabling organizations to compete more efficiently.

Warehouse Performance Benefits from Application of Multimodal Data Collection Solutions
Source: VDC Research

Metric	Value
Perfect Order	39%
Improved Inventory Accuracy	30%
Improved Customer Loyalty and Repeat Business	30%
Fill Rate Improvement	29%
Reduced Operating Costs	29%
Reduced Asset Failures	28%

With a multitude of mature automatic identification technologies available, warehouse operators are able to more effectively, efficiently and accurately run their businesses resulting in not only significant cost savings but also the ability to materially contribute to their organization's competitive position. Part of the opportunity for warehouse operators is to think of warehouses and DCs as a combination of workflows and to apply the most appropriate technology for each workflow: from voice technology for high speed picking applications to RFID for asset management and tracking and 2D barcodes for information rich applications. As supply chains continue to extend globally and cost more to operate, the application of a breadth of warehouse and DC automation solutions will be critical to achieve efficiency and performance goals and a create a more intelligent processing environment.

About Supply Chain Services

Supply Chain Services is a leading provider of best-in-class customized data collection, barcode scanning, barcode printing, rugged mobile computing, wireless networking solutions, and software that offer out-of-the-box automation and improvements for the value-chain processes of manufacturing, distribution and warehousing companies. As specialists in the automated identification and data collection (AIDC) industry, we are a single source for evaluating, designing, integrating, implementing, managing, and supporting data collection technology infrastructures that generate very high and very fast return on investment for our customers.

About VDC

VDC Research Group (VDC) is a technology market research and strategy consulting firm that advises clients in a number of technology markets including: Automatic Identification and Data Collection, Embedded Hardware and Systems, Embedded Software and Tools, Industrial Automation and Control and Mobile and Wireless. Using rigorous primary research and analysis techniques, the firm helps its clients identify, plan for and capitalize on current and emerging market opportunities. We strive to deliver exceptional value to our clients by leveraging the considerable technical, operational, educational and professional experience of our research and consulting staff. During our nearly four decades of ongoing operation, we have had the pleasure of serving most of the world's leading technology companies, many high-profile start-ups and numerous blue-chip early and later stage investors. Our products and services consist of research reports, annual research programs, and custom research and consulting services. Founded in 1971, the firm is located in the Boston area.

About Intermec

Intermec Inc. (NYSE:IN) develops and integrates products, services and technologies that identify, track and manage supply chain assets and information. Core technologies include rugged mobile computing and data collection systems, voice solutions that increase business performance, bar code printers, label media, and RFID. The Company's products and services are used by customers in many industries worldwide to improve the productivity, quality and responsiveness of business operations.

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